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WATERSHED WORK PLAN

T OR C - WILLIAMSBURG ARROYOS

SIERRA COUNTY, NEW MEXICO

NOVEMBER 1970

PHOTO COURTESY OF THE HERALD, T OR C, NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE ... SOIL CONSERVATION SERVICE

Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd. Congress, 68 Stat. 666) as amended.

Work Plan

For

Watershed Protection And Flood Prevention

T OR C-WILLIAMSBURG ARROYOS WATERSHED

Sierra County, New Mexico

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared By:

Sierra Soil and Water Conservation District
(Sponsor)

City of Truth or Consequences
(Sponsor)

Village of Williamsburg
(Sponsor)

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service

U. S. Department of Interior
Bureau of Land Management
Bureau of Sport Fisheries and Wildlife

November, 1970

WATERSHED WORK PLAN AGREEMENT

Between the

SIERRA SOIL AND WATER CONSERVATION DISTRICT
Local Organization

CITY OF TRUTH OR CONSEQUENCES
Local Organization

VILLAGE OF WILLIAMSBURG
Local Organization

(Hereinafter referred to as the Sponsoring Local Organizations)

STATE OF NEW MEXICO

and the

SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
(Hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organizations for assistance in preparing a plan for works of improvement for the T or C-Williamsburg Arroyos Watershed, State of New Mexico, under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service a mutually satisfactory plan for works of improvement for the T or C-Williamsburg Arroyos Watershed, State of New Mexico, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. Truth or Consequences and Williamsburg will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost or

value $172,500. The percentage of this cost to be borne by the sponsoring organizations and the Service listed above are as follows:

Works of Improvement	Truth or Consequences (percent)	Williamsburg (percent)	Service (percent)	Estimated Land Rights Cost (Dollars)
Floodwater Retarding Structures:				
Site 2A-1	100	---	0	40,000
Site 3C	100	---	0	53,500
Site 6B	100	---	0	25,700
Site 8C	---	100	0	7,700
Channels:				
300	100	---	0	8,800
600	100	---	0	4,300
800	---	100	0	10,000
Floodway 500	100	---	0	22,500

The city of Truth or Consequences and the village of Williamsburg agree that all land acquired or improved with credit assistance will not be sold or otherwise disposed of for the evaluated life of the project except to a public agency which will continue to maintain and operate the development in accordance with the operation and maintenance agreement.

2. Truth or Consequences and Williamsburg will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

3. The percentages of Construction Costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Estimated Construction Cost (dollars)
Floodwater Retarding Structures:			
Sites 2A-1, 3C, 6B, and 8C	0	100	1,593,900
Channels 300, 600, and 800	0	100	243,200
Floodway 500	0	100	214,400

4. The percentage of Engineering Costs to be paid by the Sponsoring Local Organizations and by the Service are as follows:

Works of Improvement	Sponsoring Local Organizations (percent)	Service (percent)	Estimated Engineering Cost (dollars)
Floodwater Retarding Structures:			
Sites 2A-1, 3C, 6B, and 8C	0	100	111,700
Channels 300, 600, and 800	0	100	23,000
Floodway 500	0	100	19,300

5. The Sponsoring Local Organizations and the Service will each bear the costs of Project Administration which it incurs, estimated to be $1,600 and $311,500 respectively. The Service will administer the construction contracts.

6. The Sierra Soil and Water Conservation District will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their lands.

7. The Sierra Soil and Water Conservation District will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sierra Soil and Water Conservation District will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The city of Truth or Consequences and the village of Williamsburg will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose. A separate agreement will be entered into between the Service and the city of Truth or Consequences and the village of Williamsburg before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

13. No member of, or delegate to Congress, or resident commissioners, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 CFS Sec. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

Sierra Soil and Water Conservation District

By Chandler Edgmon

Title Chairman

Date 11/13/70

The signing of this agreement was authorized by a resolution of the governing body of the Sierra Soil & Water District
(Local Organization)
adopted at a meeting held on 11/13/70.

Gayle Middleton
Secretary, Local Organization

11-13-70
Date

==========

City of Truth or Consequences

By John R. Guthrie

Title Mayor Pro-tem

Date November 9, 1970

The signing of this agreement was authorized by a resolution of the governing body of the City of Truth or Consequences (Local Organization) adopted at a meeting held on November 9, 1970

Jessie Billings
Secretary, Local Organization

November 9, 1970
Date

==========

Village of Williamsburg

By Hessie Pusey

Title Mayor

Date November 10th 1970

The signing of this agreement was authorized by a resolution of the governing body of the Village of Williamsburg (Local Organization) adopted at a meeting held on November 10th 1970

Hazel B. Lippert
Secretary, Local Organization

November 10th 1970
Date

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Soil Conservation Service
United States Department of Agriculture

By

Title

Date

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Sierra County, New Mexico

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WATERSHED WORK PLAN

T OR C-WILLIAMSBURG ARROYOS WATERSHED

SIERRA COUNTY, NEW MEXICO

NOVEMBER, 1970

SUMMARY OF PLAN

GENERAL SUMMARY

The watershed includes 19,050 acres or 29.8 square miles in south-central Sierra County, New Mexico. The city of Truth or Consequences and the village of Williamsburg are located in the lower end of the watershed. Over 95 percent of the urban areas of Truth or Consequences and Williamsburg are within the watershed.

The sponsoring local organizations are: The Sierra Soil and Water Conservation District; the city of Truth or Consequences; and the village of Williamsburg.

The sponsoring local organizations were provided technical assistance in developing the work plan by the Soil Conservation Service, the Bureau of Land Management, and the Bureau of Sport Fisheries and Wildlife.

WATERSHED PROBLEMS

The problems are flood damage to urban and agricultural property located near and in Truth or Consequences and Williamsburg.

Damaging floods have occurred frequently. During the past 20 years, there have been 5 floods which caused major damage and 16 other floods which caused some damage. Major damage resulted from floods in 1948, 1950, 1963, 1965, and 1967.

Average annual flood damage under future conditions of land use and development, without the project, is estimated to be $196,860, of which $113,940 is floodwater damage, and $57,220 is sediment damage and $25,700 indirect damage. Approximately 97 percent of the average annual damage is to urban property.

The proposed land treatment and structural measures will reduce flood damage in the watershed by approximately 96 percent and reduce sediment delivery from the watershed to the Rio Grande by about 66 percent. The structural works of improvement will provide protection from floods up to and including the one percent chance of occurrence flood in the damage areas below Arroyos 2, 3, 4, 5, 6, 7, and 8. This degree of protection will allow development of land and other resources which are now idle because of flooding. The project installation period is five years for land treatment and four years for structural measures. The estimated total cost of the project is $2,735,800 (Table 1). The cost of applying land treatment is $44,700 and the estimated cost of the structural measures is $2,691,100.

LAND TREATMENT

The application of land treatment measures will provide protection to rangeland and irrigated land. These measures include management practices on rangeland and cropland and the improvement of irrigation systems. Sediment yields to the proposed floodwater retarding structures will be reduced 5 percent by installation of land treatment measures on the smaller arroyos and reduced 10 percent by installation of land treatment measures on Mud Springs Canyon drainage area.

The estimated cost of applying land treatment measures on private and state land is $42,200 including $13,000 for technical assistance, of which $9,100 will be from Public Law 566 funds. The estimated cost of applying land treatment of public domain is $2,500. This cost will come from regular funds of the Bureau of Land Management.

STRUCTURAL MEASURES

Structural measures included in the plan consist of four floodwater retarding structures with three outlet channels and one floodway. The estimated installation cost is $2,691,100. Public Law 566 funds will bear $2,517,000 of the installation cost and other funds will bear the remaining cost of $174,100, which is the cost or value of land rights and local project administration. Land rights cost include costs for required structures at road and street crossings in addition to the cost or value of all land needed for the works of improvement, relocation of buildings, and relocation of fences and utilities. Local project administration costs include that spent in meetings and miscellaneous overhead costs. Local sponsors will make an application to the Farmers Home Administration for a loan to assist in the acquisition of land rights.

OPERATION AND MAINTENANCE

All costs of operating and maintaining the structural measures is the responsibility of Truth or Consequences and Williamsburg. The estimated average annual cost of operation and maintenance is $3,900. Sites 2A-1, 3C, and 6B, with associated outlet Channels 300 and 600, and Floodway 500, will be the responsibility of Truth or Consequences at an estimated average annual cost of $1,450. Site 8C and Channel 800 will be the responsibility of Williamsburg at an estimated average annual cost of $2,450.

Land treatment measures will be maintained by the landowners and operators.

BENEFITS AND COSTS

The total average annual benefits which will accrue to the structural measures amount to $242,600. The average annual cost of the structural measures is $142,730 and the benefit-cost ratio is 1.7:1.

DESCRIPTION OF THE WATERSHED

The watershed is located in the southern part of Sierra County in south-central New Mexico. Within the watershed boundaries are located most of the urban areas of Truth or Consequences (formerly Hot Springs) and Williamsburg, New Mexico, which are located along the Rio Grande about four miles below Elephant Butte Reservoir. The combined population of the urban area is approximately 5,200. The watershed has a total area of about 29.8 square miles. Approximately 4.7 square miles are within the city limits of Truth or Consequences, and 0.23 square mile is within the village of Williamsburg.

PHYSICAL DATA

The watershed is in the Desertic Basins Plains and Mountains Land Resource Area and the Basin and Range Physiographic Province. Mean sea level elevations range from 4225 in the floodplain areas along the Rio Grande to 5740 feet at the upper edge of the watershed. Annual rainfall in the watershed is less than 10 inches, and the larger percent of this falls in the months of July, August, and September. Drainages are generally steep, having low-intake soils and a poor vegetative cover.

Shallow Soils With Sparse Vegetative Cover Is Typical of the Watershed Drainage Area

SCS PHOTO 12-P620-8

Arroyos 2, 3, 4, 5, 6, and 7, as designated on the project map, head in the rocky hills just east of Mud Mountain and flow southeasterly toward the Rio Grande. They have well-defined channels typical of arroyos along the Rio Grande in this area. About one-half mile before entering the Rio Grande, the drainages pass through the escarpment into the Rio Grande floodplain where the arroyos have formed alluvial fans.

Earth channels have been constructed for arroyos 2, 6, and 7 through the alluvial floodplain. Arroyos 3, 4, and 5 do not have identified channels to the river, and floodwater spreads over urban and agricultural developments. Sediment is dropped in the floodplain area and the floodwater passes on into the Rio Grande.

These drainages are crossed by Interstate Highway I-25, which is located above the urban area in the breaks and by U. S. Highway 85,

which passes through the village of Williamsburg and the city of Truth or Consequences in the floodplain area.

Arroyo 8 - Mud Springs Canyon, designated as Arroyo 8, has a drainage area about five times greater than the combined area of the other 6 arroyos in the watershed. This drainage heads in the relatively flat mesa land where channels are poorly defined and flows southeast. About midway down, the drainage goes into the river breaks, where slopes become steep and drainages are well defined. Also in these breaks, the drainages from Mud Mountain combine with Arroyo 8. The area in the breaks is similar to the upper drainages of the other 6 arroyos within the watershed. Before entering the Rio Grande floodplain, Arroyo 8 passes under Interstate Highway I-25. The arroyo then flows into the Rio Grande floodplain where it has formed a large alluvial fan. The village of Williamsburg is located on and around this fan. U. S. Highway 85 crosses the fan through Williamsburg. Sediments are deposited on the fan, and the waters pass on into the Rio Grande.

Typical Breaks Above The Floodplain

SCS PHOTO 12-P620-11

CLIMATE

The watershed lies in a semi-arid climatic zone with relatively mild winter temperatures. Mean annual temperature is 61 degrees Fahrenheit and the average annual rainfall is 8.5 inches as recorded at the Truth or Consequences weather station. Record temperatures are a high of 109 degrees F., and a low of -5 degrees F. The normal frost-free period is 220 days. Rainfall usually occurs during thunderstorms of high intensity and short duration, frequently associated with severe hail.

GEOLOGY

The area is one of complex folding and faulting with steep mountain areas underlain by eastward dipping beds of Paleozoic to Precambrian Age rocks. The lower reaches of the watershed can be described as a dissected floodplain. Here the arroyos are incised into Tertiary Age Santa Fe beds and Quaternary to Recent alluvium with few exposures of the older rocks. The Mud Springs Fault Zone, striking northwestward, passes a few hundred feet north and parallel to Mud Springs Canyon. This major thrust fault is believed to be Laramide in age.

On the southern side of the Fault, the down-thrown side, the Santa Fe beds abut against Precambrian granite. Subsequent to this major faulting, block faulting in the Caballo Mountains, an area immediately to the east, has been assigned to Miocene and later time or synchroneous with Santa Fe deposition. Evidence of modern movement along the fault plane, or record of such movement in the literature researched, was not found.

GROUNDWATER

Water for irrigation within the watershed is obtained from wells and from the Rio Grande. Municipal water is supplied by wells in the alluvial soils at the mouth of Mud Springs Canyon. The city-owned wells flowed 300 gallons per minute upon completion. These flows were the result of the gradient of the stream valley. At the present time, the wells are pumped. Two irrigation wells, located 1000 feet upstream of the city wells and completed in 1968, found the water table at 40 feet. Based on pumping tests of the city wells, the groundwater discharge to the Rio Grande in the vicinity of Mud Springs Canyon is reported to be one cubic foot per second per mile along the river. Wells within Mud Springs Canyon, pumped by windmills, tap perched water which is confined by clay beds. Other parts of the watershed upland are barren of groundwater.

Groundwater within the city of Truth or Consequences consists of hot artesian waters from the Magdalena beds of Pennsylvanian Age and the overlying alluvium. These waters apparently originate at great depth and rise along the fault plane of the Mud Springs Fault migrating up dip in the Magdalena beds to issue forth as springs in the center of town. These springs are no longer free-flowing and are now being pumped.

SOILS

There are nine soil associations identified in the watershed, and these are shown on the table in the investigation and analyses section of the plan. Soil characteristics, interpretations, and other related factors are shown in the table.

Soils range from deep, loamy bottomland soils to shallow gravelly soils. The deep, loamy, bottomland soils are found along the Rio Grande floodplain. In the upper part of Mud Springs Canyon (Arroyo 8), soils are loamy to clayey and deep to moderately deep. The soils in the river breaks, which include the middle reaches of Mud Springs Canyon and the upper reaches of the other arroyos, are shallow upland soils ranging from loamy to gravelly. About 20 percent of this upland area is barren, eroded geologic materials described as badland.

The Deeper Sandy Soils Have More Vegetative Cover

SCS PHOTO 12-P620-16

VEGETATION

The swale areas located in the upper half of the watershed have tobosa, vine mesquite, and sacaton grasses. The grass cover varies from poor to good on these areas.

Rangeland outside the swale areas support creosote, tarbush, mesquite, and yucca with a sparse cover of fluffgrass, black grama, and sideoats grama intermingled with the brush species.

The rough broken areas have black grama and sideoats grama grass on the north and east slopes. The south and west slopes support creosote and mesquite bush with a very sparse cover of fluffgrass, black grama, and sideoats grama.

LAND TREATMENT DATA

The project area is furnished technical assistance by the Soil Conservation Service Work Unit at Truth or Consequences, New Mexico, in cooperation with the Sierra Soil and Water Conservation District.

The upland area is occupied by six ranches of which four cover the major portion of the watershed area.

Four irrigated farms, the village of Williamsburg and the city of Truth or Consequences are located below the escarpment on the alluvial fans and in the floodplain.

Six basic conservation plans have been developed on 9,971 acres in the watershed. Excluding the urban area, 66 percent of the watershed is covered by conservation agreements. Approximately 25 percent of the needed land treatment has been applied on federal, state and private land.

Activity in the conservation program has increased since the application for flood control assistance was submitted. Most of the ranch units have more acres of land outside the watershed boundaries than inside. A high percentage of the land is public domain which is administered by the Bureau of Land Management with grazing permits to individual ranchers.

ECONOMIC DATA

The damage area of the watershed is primarily urban property in Truth or Consequences and Williamsburg. Truth or Consequences is the

county seat of Sierra County. Williamsburg is immediately west of the Truth or Consequences city limits.

The two urban communities have a combined population of approximately 5,200. Approximately 2,000 persons live within the floodplains of the arroyos.

The economy of Truth or Consequences and Williamsburg is based on tourist trade, recreation and agriculture. It is estimated that about 65 percent of the economy stems from tourist trade and recreation, 30 percent from agriculture, and 5 percent from miscellaneous sources.

The present land use and land status of watershed land is as follows:

Land Use	Acres				Percent
	Private	State	Federal (Public Domain)	Total	
Rangeland	1,757	1,920	11,350	15,027	78.9
Urban and Misc.	3,339	600	---	3,939	20.7
Irrigated Land	84	---	---	84	0.4
TOTAL	5,180	2,520	11,350	19,050	100.0
PERCENT	27.2	13.2	59.6	100.0	

Truth or Consequences is the general trade area for Sierra County and several small communities in adjoining counties. Ranchers in the Beaverhead area in Catron County and in the Dusty community of Socorro County obtain supplies and service in Truth or Consequences.

There are approximately 360 farms and ranches in Sierra County covering about 2,358,000 acres of land, including about 9,800 acres of irrigated land. The owners and operators of these 360 operating units purchase supplies and services in the county seat. Truth or Consequences is the principal trade center for a number of outlying communities in the county. Residents of the Hillsboro, Kingston, Winston, Chloride, Monticello, Cuchillo, Arrey, Caballo, Derry, Las Palomas, and Engel come to Truth or Consequences to trade.

This area has long been known for its mineral hot water which attracts a significant number of visitors during the winter months. Many who come for the mineral hot water treatment are retired people who stay for the winter season.

Elephant Butte Reservoir, located four miles east of Truth or Consequences, and Caballo Lake, located 12 miles south, were constructed by the Bureau of Reclamation for the storage of irrigation water and to generate electric power. Both reservoirs are now used year round for recreation. Adjacent areas at both developments have been designated as State Parks.

Elephant Butte Reservoir Recreational Area

SCS PHOTO 12-P1001-12

Transportation facilities serving the communities in the watershed include U. S. Highway 85 and State Roads 52, 90, and 142. The recent completion of Interstate Highway I-25 has improved the transportation facilities serving this area of the state and watershed communities.

The population of Truth or Consequences and Williamsburg was approximately 4600 in 1960. The 1970 population for the two communities is 5200. This is an increase of about 13 percent in ten years. This rate of growth is projected over the next twenty years, resulting in a population of approximately 6500 by 1990. The projected population for Truth or Consequences and Williamsburg is about 9,500 by the end of this century.

Recent commercial development in Williamsburg includes the building of two service stations, and land has been purchased for three additional service stations in this area of the watershed. Other related facilities such as motels and restaurants are under consideration following the completion of Interstate 25. Local planning groups expect the Williamsburg area of the watershed and the west portion of Truth or Consequences to be expanded by both residential and commercial developments within 15 years.

The available residential and commercial areas remaining to be developed in Williamsburg are expected to be completed within 10 years and significant areas in Truth or Consequences within 15 years.

The steady growth of Truth or Consequences and Williamsburg is indicated by the population increase and other key economic indicators for the years 1965 and 1968:

	1965	1968
Population	4,700	4,950
Bank Deposits	$6,457,000	$7,482,000
Building Permits	$96,000	$122,800
Telephone Customers	1,946	2,456
Electric Consumers	2,020	2,250

The 84 acres of irrigated land in the watershed is operated as four farms. Water for irrigation is obtained from private wells or pumped from the Rio Grande. The principal crop grown is alfalfa. There are a few acres in small grains and pasture. None of the four farms employ one and one-half man years or more of hired labor per year.

Approximately 75 percent of the rangeland is federal land administered by the Bureau of Land Management through grazing permits with individual ranchers. Three sections of state land are leased by individual ranchers for grazing.

Value of land varies from $30 per acre in the upland portion of the watershed to $5000 per acre in highly developed commercial and residential areas. The irrigated cropland is valued at a minimum of $1000 per acre and some is valued at $1500 per acre. Some areas subject to frequent flooding have remained idle and undeveloped. Without flood protection, these lands have a low market value.

FISH AND WILDLIFE RESOURCES

Wildlife which inhabit the watershed area in order of importance are scaled quail, Gambel's quail, mourning dove, antelope, and mule deer.

Recent surveys conducted by the New Mexico Department of Game and Fish show that quail hunters are enjoying modest success in the watershed area and the general vicinity.

WATERSHED PROBLEMS

Flooding, sediment deposition, and erosion are problems on 7 arroyos in the watershed - Arroyos 2 through 8 (See Urban Floodplain Map, Figure 8). All flooding and associated problems result from intermittent high flows of short duration which occur during summer thunderstorms.

Arroyo 2 enters the urban area of the city of Truth or Consequences where it passes under U. S. Highway 85. Below this point, the constructed channel has very little grade and requires regular cleanout in order to maintain the channel. Streets crossing the channel require maintenance after each flow. Larger flows can either overflow or wash through the dikes which are constructed from alluvial materials. Adjacent urban areas are about level with the channel bottom, thus when the channel does break, flows spread out through the urban area.

Arroyos 3, 4, and 5 join just above Marshall Street, where they enter the urban area of Truth or Consequences. The channel is large from where Arroyos 3 and 4 join down to where it passes under U. S. Highway 85. The major problems above U. S. Highway 85 are bank erosion and damage to street crossing. Below the highway, the channel ends and the waters spread out flooding a large area of the city before reaching the Rio Grande. Much of this area is undeveloped and streets are unuseable because of the flooding and sediment deposition. Also, farmland along the river is flooded.

Arroyos 6 and 7 flow through the urban area of Truth or Consequences down to Cook Street. Erosion of the channels is a constant problem, while the larger flows cause flooding of the urban area. The two arroyos join immediately below Cook Street just above the county fair buildings. Here their waters spread out and join with Arroyo 8. U. S. Highway 85 crosses the common floodplain of Arroyos 6, 7, and 8. Flood problems in this area are the same as for Arroyo 8.

Flood Damage to Agricultural Land

SCS PHOTO 12-PS66-7

Arroyo 8 passes under Interstate I-25 just before entering the city limits of Truth or Consequences. Here it enters the common floodplain with Arroyos 6 and 7. Above U. S. Highway 85, waters back up causing deep flooding and sediment deposition. Sediments have built up until this area is higher than the old part of the village of Williamsburg. Also, sediments are beginning to move on into the river where it is expected they will have to be removed.

FLOODWATER DAMAGE

Floods from high-intensity thunderstorms occur frequently. Recorded data show there have been 21 damaging floods during the past 20 years. Major damage resulted from the following floods: June, 1948; July, 1950; August, 1963; September, 1965; and September, 1967.

Floods occur principally in the summer and early fall months. The 21 damaging floods occurred in the following months; 17 floods in July, August, and September; 2 floods in October; 1 flood in June; and 1 flood in November.

Flood damage from the September, 1965 storm is typical of damage incurred in the watershed.

The 1965 flood caused damage in all areas of the watershed. The heaviest damage was in Williamsburg where 33 homes were flooded. Homes were also flooded in Truth or Consequences. The estimated residential damage by floodwater was $44,500 from the 1965 flood.

Damage to commercial property included three garages, two small motels, several apartment buildings, and five stores. The estimated floodwater damage to commercial property was $12,000.

Streets, roads and highways were damaged heavily by floodwater. Truth or Consequences, Sierra County, Williamsburg, and the New Mexico State Highway Department spent approximately $8500 repairing floodwater damage to streets and roads. Road crossings were washed out in several places causing detours in travel. U. S. Highway 85 required repair in several locations.

Damage to flood prevention works built by the municipal governments and by individual property owners was substantial. Flood detention structures, levees, dikes and channel revetment works of improvement were damaged. The estimated damage by floodwater to these existing structures in 1965 was $5500.

Floodwater damage to agricultural property consisted of crop loss, damages to quality of crops, damage to land by washing out of borders, irrigation ditches, and flooding farm homes. Approximately 75 acres of irrigated cropland and pastureland were flooded up to depths of one foot. The estimated damage to agricultural property in 1965 was $3000.

A flood of the same magnitude as the 1965 flood would now cause considerably more damage. The same size flood in the future, with projected increased development, would cause several times the damage reported in 1965. Average annual floodwater damage under future conditions of development in the watershed without structural measures is estimated to be $113,940.

South Broadway (U. S. Highway 85) Flood Damage

SCS PHOTO 12-P566-5

SEDIMENT DAMAGE

Sediment deposition causes some damage to irrigated land, crops, and irrigation systems. However, major damage by sediment in the watershed is to urban property. Residential and commercial property, roads, streets, highways, and drainage channels or arroyos are damaged by sediment deposition. The lower reach of Arroyo 2 is particularly susceptible to sediment damage because of its low gradient. Sediment deposition occurs in yards and on lawns and in areas available for future development. The removal of sediment from culverts, bridges, and channels is a significant annual cost to the municipal governments. Other sediment damage is to the Rio Grande and Caballo Reservoir. Sediment damage to Caballo Reservoir was not evaluated in monetary terms; capacity depletion of significance would be several times longer than the 100-year evaluation period for this project.

The 1965 flood caused sediment damage to the following property and facilities: residential property - $17,000; commercial property - $6000; transportation facilities - $8000; existing flood prevention

works and arroyo channels - $3500; and $1500 to agricultural property. The progressive build-up of sediment in channels and in the damage area will increase the cost of sediment removal significantly within the next 20 years. The average annual damage from sediment under future conditions of development without the project is estimated to be $57,220.

Sediment Deposited on Irrigated Cropland

SCS PHOTO 12-P566-8

EROSION DAMAGE

Erosion of the upland soils of the watershed is relatively high. The average annual gross erosion is estimated to be 1.2 acre feet per square mile with a maximum of 1.6 acre feet. It is estimated sheet and rill erosion is the source of 69 percent of the damaging sediments, and arroyo bank and gully erosion supply the remainder. Erosion on the irrigated lands is negligible. Monetary damage from erosion is included with floodwater and sediment damage estimates.

PROBLEMS RELATING TO WATER MANAGEMENT

DRAINAGE

There are no drainage problems on the agricultural lands. There is an area of non-agricultural land near Arroyo 2 and adjacent to the Rio Grande with a high water table. This condition has prevented the development of residential property or other use of the land involved.

IRRIGATION

The four farms in the watershed are irrigated on individual systems by pumping water from wells or from the Rio Grande. The quality of water is suitable for irrigating all crops, and the quantity is adequate for the area under cultivation. The present area under irrigation is 84 acres which is used for the production of alfalfa, pasture and small grains. These crops are adapted to the climatic and soils conditions. The threat and the frequency of flooding has prevented farm owners from making needed improvements to the irrigation systems and in some cases of properly leveling land for efficient irrigation.

MUNICIPAL AND INDUSTRIAL WATER

Municipal water is supplied by wells in the alluvial soils at the mouth of Mud Springs Canyon. The supply of water for the municipal needs of Truth or Consequences and Williamsburg is considered adequate. As the needs increase with the population growth, additional wells will be developed.

FISH AND WILDLIFE

Wildlife inhabiting the watershed area include quail, doves, antelope, and mule deer. The inadequate water supply prevents development of water-based recreation and limits wildlife population in the watershed.

PROJECTS OF OTHER AGENCIES

During the past 18 years, the city of Truth or Consequences has constructed six detention dams within the city limits. These structures are earth dams with corrugated metal pipe outlets. Two of these dams are on arroyos east of U. S. Highway 85.

The four detention dams located west of U. S. Highway 85, are on Arroyo 1 at Marie Street, Arroyo 2 above proposed Site 2A-1, Arroyo 5, and Arroyo 6. These structures have been fairly effective in controlling floods which have occurred to date.

Owners of private property in Truth or Consequences and Williamsburg have spent about $33,000 for bank protection on arroyo channels, levees, dikes, and retaining walls.

PROJECT FORMULATION

PROJECT OBJECTIVES

The objectives of the project are to provide flood protection to Truth or Consequences and Williamsburg, to reduce deterioration of the rangeland by improving vegetative cover, to reduce erosion, and to reduce sediment deposition on urban and agricultural lands and to the Rio Grande.

Formulation of the land treatment measures and flood prevention structural measures is to be in the framework of assisting in the full development and stabilization of the economy of the watershed.

Land treatment measures and the structural measures selected for inclusion in the plan are those that meet the project objectives at the lowest annual cost. The level of flood protection was agreed to by the sponsors, the Bureau of Land Management, and the Service as being adequate to provide both reduction of flood damage and the development and use of the land and water related resources. This agreed-on level of protection will meet project objectives.

Measures to enhance wildlife resources were considered. However, due to a lack of perennial water in the arroyos and the low annual rainfall in the area, fish or wildlife enhancement was not considered as a project objective. Project measures to meet the flood protection objectives will not adversely affect fish or wildlife habitat.

Other water resource plans existing or being developed for this area were considered in the formulation of this project. This plan is compatible with existing plans and will not preclude full development of the area.

LAND TREATMENT

Land treatment measures included in the plan will provide for the conservation, development, and improvement of the land and water resources.

The measures included are those needed to stabilize land and improve the management of the resources, and reduce sediment deposition in the urban and farm area.

Land treatment measures were given first consideration in obtaining or solving the project objectives. Structural measures were then considered to meet and accomplish the desired objectives.

STRUCTURAL MEASURES

Structural measures in this plan were selected on the basis of effective and economic accomplishment of flood prevention objectives. Several alternative combinations of structural measures were investigated during planning. The final determination of measures to be included in the plan was made by the sponsors after consideration of the desired objectives and the alternative solutions investigated.

The minimum level of protection was set at the one percent chance of flooding. This minimum was set because all structural works would be controlling flooding in urban areas. Where site conditions permitted, costs were analyzed for detention of floodwater from storms larger than one percent chance of occurrence storm. The level of flood protection to agricultural land agreed on is the same as for urban property since the agricultural land is intermingled or closely located with the urban areas.

In evaluating alternative structural measures to accomplish flood protection objectives, detention reservoirs were considered as the first choice. Channel improvement was used below the detention structures to control the principal spillway flows and flows from areas below the structures. Channel improvement was also added in Arroyo 5 where storage was too costly to accomplish the necessary control.

Final formulation of the structural measures, including floodwater retarding structures with associated channels and the floodway, was made recognizing that Arroyo 1 and small contributing areas between arroyos would remain uncontrolled. No feasible or economically justifiable means of controlling all runoff within the communities was found.

Arroyo 1 was evaluated and found to have an inadequate reservoir site and excessive cost of channeling in the urban area. Existing channel with maintenance could control a four percent chance flow through the urban area. After consideration of these evaluations, the local sponsors requested that flood control on Arroyo 1 be left out of the plan.

Arroyo 2 will have a floodwater retarding structure located as close to the urban area as feasible to reduce the drainage area below

the structure and to intercept sediment from a highly erosive area located just above the urban area. Maximum economic detention capacity is planned in the retarding pool. The detention capacity will be greater than the runoff from a one percent chance event, and will also store the 100-year sediment accumulation. Cost was the principal consideration in sizing the structure for runoff greater than the one percent chance event. Estimated cost for the structure was less by providing for larger storage. This was because operation frequency, flow duration, and depth of flow through the emergency spillway was less, thus reducing the required stabilization. The principal spillway discharge will be kept small to minimize structural works in the outlet channel.

Arroyos 3 and 4 will have a floodwater retarding structure located where it will retard flows from both arroyos. Maximum economic detention capacity is planned in the retarding pool, which is greater than that required for retarding of the one percent chance runoff. Also, it will allow for a 100-year sediment storage. Cost was the principal consideration in sizing the structure for retarding runoffs from storms greater than the one percent chance event. Estimated cost for the structure was less by providing for larger storage. This was because operation frequency, flow duration, and depth of flow through the emergency spillway was less, thus reducing the required stabilization. The principal spillway discharge will be kept small to minimize structural works in the outlet channel. The outlet channel is planned to carry the principal spillway discharge and to control flows from the intervening areas for storms up to and including the one percent chance event.

Arroyo 5 was evaluated for a retarding structure but, because of urban development in and below the planned emergency spillway, it was determined unfeasible. Maximum economic benefits were obtained with Floodway 500 by making use of flood control works being installed as a part of the new U. S. Highway 85, and combining Channel 300 with Floodway 500. Control of flows up to and including the one percent chance event is planned for. A cover on the channels is planned at the junction to control turbulence caused by high velocity flows coming together.

Arroyos 6 and 7 will have a floodwater retarding structure built at a location where it will retard flows from both arroyos. Principal spillway flows will be kept small enough to allow using pipe from the structure to Cook Street. The pipe is planned in this section because of the steep grade and highly erosive material. Below Cook Street there is an existing channel with less grade and erosion is not a problem. The structure is planned to retard runoff from storms up to and including the one percent chance events. Also, storage is planned for 100 years of sediment accumulation.

Arroyo 8 has a floodwater retarding structure planned to store the 100-year sediment and to retard the floodwater from a one percent chance event. The principal spillway discharge will be kept small to reduce costs in the outlet channel. The outlet channel is planned to convey the principal spillway discharge to the Rio Grande. Also, one percent chance flows from the intervening areas will be controlled by the outlet channel.

WORKS OF IMPROVEMENT TO BE INSTALLED

LAND TREATMENT MEASURES

This plan provides for acceleration of conservation planning and practice application on private and state-owned lands in cooperation with the Sierra Soil and Water Conservation District.

Public Law 566 funds to accelerate land treatment amount to $9,100 for Soil Conservation Service technical assistance. Cost sharing of conservation practice application through the going Agricultural Conservation Program will be encouraged.

Land to be treated is shown in Table 1 by acres and land use. This treatment will be planned and applied by the landowners in cooperation with Sierra Soil and Water Conservation District. State land is to be treated with the private land by the lessees with the concurrence of the New Mexico State Land Commissioner.

To reach the objectives of the sponsors for the land treatment, practices of proper grazing use, deferred grazing, water development, net wire diversions, contour furrowing, erosion control dams, and brush control will be applied as a system of treatment on 3,677 acres of private and state land. Nearly all of this treatment will be carried out on the upland portion of the watershed.

The Bureau of Land Management will continue to assist ranchers in carrying out land treatment measures on 11,350 acres of federal rangeland. Proper grazing use is planned on all of the federal land.

Land treatment to be carried out on 84 acres of irrigated land includes improved irrigation systems, improved cropping and pasture management systems, and better irrigation water management. Adequate soils information is available in general soil surveys made by the Soil Conservation Service.

The land treatment measures shown in Table 1 were jointly agreed upon by the Sierra Soil and Water Conservation District, the Bureau of Land Management and the Soil Conservation Service. These measures will be planned and applied during the project installation period.

STRUCTURAL MEASURES

Structural improvements to be installed will be four single-purpose floodwater retarding structures, two outlet channels, one outlet pipeline, and one floodway. The floodwater retarding structures are all planned with a dry pool and a design life of 100 years. The principal spillway riser for each structure will be designed to permit drainage of the sediment pool. These retarding structures control 80 percent of the watershed. The channels and floodway are all planned to control the principal spillway flows and the one percent chance flows from intervening areas. There is planned 3720 feet of channeling, 2965 feet of floodway, and 1440 feet of pipeline.

Site 2A-1 is located within the city limits of Truth or Consequences. This will be a single-purpose floodwater retarding structure to provide flood protection to urban property. This structure controls 1.12 square miles of drainage.

The dam will be an earth-gravel fill with a compacted earth core. The dam will be about 63 feet high, 735 feet long at the crest, have a top width of 19 feet, and a total embankment volume of 187,000 cubic yards. Both slopes will be 2 1/2 to 1, except the slope below the upstream berm which will be 3.5:1. A 10-foot berm is planned on both slopes. The foundation is massive clay beds and sand and gravel fills. Some differential yielding could occur in the foundation, but the principal spillway can be set on a uniformly yielding foundation.

At the elevation of the emergency spillway, the total capacity is 504 acre feet and the surface area is 23.5 acres. Seventy-four acre feet of the capacity has been provided for storage of the 100-year sediment accumulation. The remaining 430 acre feet of retarding storage and the principal spillway will provide control for the emergency spillway design storm. This gives control for a storm of about 3 times the one percent chance of occurrence storm.

The principal spillway is planned as a 30-inch pipe supported by concrete cradle. The riser will be ported to control the discharge during storms up to the one percent event. For storms greater than one percent chance, the pipe will flow full. The riser weir will be set at the high-water elevation for the one percent chance storm. An energy dissipating structure is planned to dissipate the energy at the outlet end. Runoff equivalent to that obtained from a 25-year, 6-hour storm can be discharged within 44 hours.

The emergency spillway is planned as a 110-foot earth spillway having soil-cement in the control section and is located in the right abutment. This spillway will only flow for storms of greater magnitude than the emergency spillway design storm, which is about 3 times as large as the one percent chance storm.

One house located within the floodwater retarding pool will have to be removed. The powerline and road to the house will be abandoned.

Site 3C will be a single-purpose structure for flood prevention located on Arroyos 3 and 4, approximately 2,860 feet north of U. S. Highway 85 and within the city limits of Truth or Consequences. It will control runoff from 1.29 square miles and will provide protection to agricultural lands and urban areas.

The dam will be a compacted earth fill structure, constructed with material available at the site ranging from clays to silty sands. It will be about 39 feet high, will have a top width of 16 feet, a top length of 1,280 feet and a total embankment volume of approximately 160,800 cubic yards. The upstream slope of the embankment will be 3:1 and the downstream slope will be 2:1. The foundation consists of gravelly silty sands with minor yielding potential.

At the elevation of the emergency spillway, the storage capacity is 620 acre-feet and the surface area is 43 acres. One hundred four acre-feet of capacity has been provided for the 100-year sediment accumulation. The remaining 516 acre-feet of retarding storage and the principal spillway will provide control for the emergency spillway design storm which is approximately 3 times greater than the one percent chance of occurrence storms.

The principal spillway is planned as a 30-inch concrete pipe supported by a concrete cradle. The top of the riser will be set at the maximum water surface elevation reached during routing of the hydrograph resulting from the one percent chance of occurrence storm. An orifice is planned to permit a maximum discharge rate of 15 c.f.s. for storms up to and including the one percent chance of occurrence flood.

Maximum principal spillway discharge with the water surface at crest of emergency spillway will be approximately 144 c.f.s. An energy dissipator designed for this capacity is planned at the outlet end. Runoff equivalent from that obtained from a 25-year, 6-hour storm can be discharged within 65 hours.

The emergency spillway is planned as a 200 foot earth spillway having soil cement in the control section and is located in the left

abutment. The spillway will flow only for storms of greater magnitude than the emergency spillway design storm, which is about three times as large as the one percent chance storm.

It is planned that Morgan Street will be relocated to the east of the structure.

Site 6B is a single-purpose structure for flood prevention located on Arroyos 6 and 7, approximately 2,000 feet north of U. S. Highway 85.

It will control the runoff from 1.04 square miles and will provide protection to urban areas. The dam will be a compacted earth fill structure, constructed with the material available at the site, ranging from clays to silty sands. It is planned to be about 37 feet high, will have a top width of 16 feet, a top length of 1500 feet, and a total embankment volume of approximately 184,000 cubic yards. The upstream slope of the embankment is planned at 3:1 and the downstream slope at 2:1.

The foundation consists of clays and silty sands with some yielding potential.

The total storage capacity to the elevation of the emergency spillway is 196 acre-feet with a surface area of 17 acres. One hundred acre-feet of the storage has been provided for the 100-year sediment accumulation. The floodwater detention capacity of 96 acre-feet is equal to the runoff from the one percent chance of occurrence storm.

The principal spillway is planned as a 30-inch concrete pipe supported by a concrete cradle. An energy dissipating structure is planned at the outlet end of the principal spillway. The top of the riser will be set at the crest elevation of the emergency spillway. An orifice is planned to permit a maximum discharge of 16 cubic feet per second for storms up to and including the one percent chance of occurrence flood. Runoff from a 25-year, 6-hour storm can be discharged within 60 hours.

The emergency spillway is planned as a reinforced concrete chute spillway with a de-energizing basin at the outlet. The inlet and channel portions of the spillway are designed to convey the routed freeboard hydrograph. The de-energizing basin is designed for the peak flow of the emergency spillway design hydrograph.

Site 8C, Mud Springs Canyon, will be a single-purpose flood retarding structure. The dam will be located on Mud Springs Canyon about one mile upstream from Williamsburg and about one and one-half miles from its confluence with the Rio Grande.

The dam is planned to be constructed of clayey sands and gravels with a compacted impervious earth core and a gravel shell one foot thick. The dam will be about 83 feet high, with a 21 foot top, a crest length of approximately 1900 feet, and a fill of approximately 968,000 cubic yards. The upstream and downstream slopes will be 2.5 to 1, each having a 12 foot berm at approximately elevation 4440.0. The foundation is clayey sands and gravels, with minor but uniformly yielding potential.

Site 8C will have a storage capacity of 1714 acre-feet. This includes 771 acre-feet for storage of the 100-year sediment accumulation, and 943 acre-feet of floodwater storage with a surface area of 68 acres. Control of the one percent chance of occurrence storm will be provided by the retarding storage and the principal spillway. This structure will control flooding from a drainage area of 20.4 square miles which is 68 percent of the total watershed area.

The principal spillway is planned as a 3' x 4' reinforced concrete box, without control gates. The inlet riser will extend to the elevation of the 100-year sediment accumulation and be ported to allow drainage of the sediment pool. A reinforced concrete structure is planned to dissipate energy at the outlet. Runoff equivalent to that resulting from a 25-year, 6-hour storm can be discharged within 36 hours.

The emergency spillway is planned as a concrete chute over the dam having a width of 100 feet, a depth of 17 feet, and the crest set at elevation 4458.0. The chute will pass the emergency spillway design hydrograph of 12,104 c.f.s. and the freeboard hydrograph of 21,598 c.f.s.

A ranch road which goes up the arroyo will be relocated around the structure.

CHANNELS

Channel 300 is planned as a rectangular reinforced concrete channel with a bottom width of 7.0 feet and a depth of 3.3 feet. The channel as planned is approximately 1080 feet long. The channel will be covered with reinforced concrete for about 50 feet before it enters Floodway 500. The material through which the channel will be constructed is a silty sand. The channel is planned to convey the principal spillway discharge from Site 3C and the runoff from the uncontrolled drainage area between Site 3C and Channel 300 into Floodway 500. The capacity is planned for the principal spillway discharge and the runoff from a one percent chance of occurrence storm from the uncontrolled area.

Other pertinent data are shown in Figure 3 and Table 3A.

Outlet 600 (Drain pipe) is planned as an 18-inch diameter pipe from the outlet structure of Site 6B south to just across Cook Street. The pipeline will be about 1440 feet in length and will be installed in a sandy soil material.

The capacity of the pipeline is the planned discharge from the principal spillway of Site 6B for the one percent chance of occurrence storm.

At Cook Street; there is a city waterline on each side of the street. The planned pipeline will be installed at a depth so that it will not interfere with the city lines. Installation will include a reinforced concrete inlet structure at the outlet of Site 6B and a reinforced concrete energy dissipator at the outlet end of the pipe.

Other pertinent data are shown in Figure 4 and Tables 3A and 3B.

Floodway 500 is planned as a rectangular reinforced concrete channel with a bottom width of 10 feet, a depth of 2.7 feet for about 620 feet, 4.8 feet deep for about 740 feet, and 5.0 feet deep for about 1605 feet and a total length of about 2965 feet. About 1500 feet of the upper end of the channel will be contructed in silty sands with the lower end constructed in silty clays. The capacity of the floodway is planned to carry peak flows from the one percent chance of occurrence storm from Arroyo 5 and Channel 300. The floodway will be covered with reinforced concrete for about 100 feet where Channel 300 enters.

Two concrete structures, 501 and 505, are planned to inlet water from the uncontrolled areas. Structure 501 has a capacity of 10 c.f.s and Structure 505 has a capacity of 75 c.f.s. A reinforced concrete structure, 507, is planned at the end of the floodway to outlet flows to the Rio Grande.

Other pertinent data are shown in Figure 3 and Tables 3A and 3B.

Channel 800 is planned to convey the principal spillway discharge of 370 c.f.s. from Site 8C to the Rio Grande. The channel is also planned to control flooding from the intervening areas below Site 8C for storms up to and including the one percent chance event. Channel improvement will consist of a standard drop below the principal spillway of Site 8C, approximately 1700 feet of earth channel having one standard drop, and about 1000 feet of concrete-lined channel with an outlet structure into the Rio Grande.

In the upper portion of the arroyo, above where channel improvements begin, materials are coarse sands and gravels. Stability studies

show that several feet of degradation may occur before armoring stabilizes the arroyo. However, because of the high sediment accumulation expected from the steep sidehills and the isolated area, this scouring is considered desirable. A standard 10 foot drop designed to pass 500 c.f.s. is planned below the outlet structure of Site 8C principal spillway to assure that anticipated scouring will not endanger the structure.

Channel improvement begins 1700 feet upstream from U. S. Highway 85. Here a training dike and a 10-foot standard drop designed to carry 1040 c.f.s. is planned. The channel from this point to U. S. Highway 85 is planned as an earth channel designed to carry 1040 c.f.s. Stability studies indicate scouring will be less than one foot with the clear water flows. From U. S. Highway 85 to the Rio Grande, a concrete-lined channel is planned to carry 1350 c.f.s. A structure which will function with varying tail water depths is planned at the outlet into the river.

The existing box culverts under U. S. Highway 85 have adequate capacity and will require only transition sections between culverts and channels.

EXPLANATION OF INSTALLATION COSTS

LAND TREATMENT MEASURES

The installation cost of land treatment measures which is summarized in Table 1 includes the cost of technical assistance needed to carry out the planned land treatment, as well as the cost of establishing the measures.

The cost of establishing these measures on private and state land is estimated to be $29,200, and the cost of technical assistance is estimated to be $13,000. Technical assistance includes conservation planning and the application of the planned conservation work, such as site selection, layout, and supervision of installation.

Accelerated technical assistance to be paid from Public Law 566 funds amounts to $9,100. Regular assistance from the going district program amounts to $3,900. Land treatment measures planned on the 11,350 acres of public domain is range proper use. The estimated cost of carrying out range proper use on public domain is $2,500 during the five-year installation period. Regular funds of the Bureau of Land Management will bear this cost.

STRUCTURAL MEASURES

The total estimated installation costs of the structural measures is $2,691,100. This cost includes costs of construction, engineering, project administration, and land rights. A tabulation of installation cost items for the structural measures is included in Table 2. Estimated Public Law 566 cost for structural measures is $2,517,000, and the cost to funds other than Public Law 566 is $174,100.

Public Law 566 funds will bear the estimated construction cost of $2,051,500, the engineering costs of $154,000, and $311,500 of the cost for project administration. Funds from other sources will bear $1600 of the cost for project administration and all costs of land rights, which are estimated to be $172,500.

CONSTRUCTION

Construction cost of the four floodwater retarding structures, three outlet channels and one floodway is estimated to be $2,051,500.

Included in these costs are clearing, site preparation, earth fill, excavation, spillways, stabilization structures, concrete channels, and cost of water for construction. These costs include a 20 percent contingency allowance for unforeseen costs on all construction, except 15 percent was used on Site 8C.

ENGINEERING

Engineering includes geologic foundation investigations, construction materials investigations, engineering designs, and preparation of plans and specifications. Engineering costs are estimated to be $154,000.

PROJECT ADMINISTRATION

These costs include administrative costs, contract administration, review of engineering plans by others, construction surveys, and inspection during construction. The estimated Public Law 566 cost of project administration is $311,500 of which $176,300 is for construction inspection and $135,200 is for other costs of project administration.

The Soil Conservation Service will administer the construction contracts.

The cost of project administration to the local sponsors is estimated to be $1600. This includes cost of time in meetings and other miscellaneous overhead costs.

LAND RIGHTS

The sponsoring local organizations will secure all land and water rights needed for the installation of the structural measures. Included are changes or relocation of roads, highways, streets, and road crossings, removal and relocation of buildings, utilities, and relocation and reconstruction of fences.

The installation of the structural measures will require approximately 323 acres of land at an estimated cost or value of $129,000.

Removal of a house in the pool area of Site 2A-1 is estimated to cost $7000.

The estimated cost of culverts, road and street crossings is $29,500; relocation of utilities and fences is $1500; and the cost of legal surveys is $2300.

FUND OBLIGATION

The estimated obligation of funds for each fiscal year during the project installation period is shown in the following tabulations:

Land Treatment - (Dollars)

Year	Public Law 566 Funds (For Accelerated Technical Assistance)	Other Funds
First	2,000	6,620
Second	2,000	6,620
Third	2,000	6,620
Fourth	2,000	6,620
Fifth	1,100	6,620
TOTAL	9,100	33,100

Structural Measures - (Dollars)

Year	Public Law 566 Funds	All Other Funds
First	150,000	48,700
Second	1,400,000	85,200
Third	745,000	30,200
Fourth	222,000	10,000
TOTAL	2,517,000	174,100

EFFECTS OF WORKS OF IMPROVEMENT

Land treatment and structural measures were evaluated to determine the effects the installation of the project would have in reducing flood damage. In addition to the flood damage reduction effects, an evaluation and analysis was made to determine enhancement values on land use changes in the floodplain which will result from the project.

LAND TREATMENT

The land treatment program to be installed will improve the vegetative cover on the rangeland. This in turn will reduce erosion on the rangeland and reduce sediment deposition on urban and agricultural lands in the floodplain.

Sediment yields to proposed Sites 2A-1, 3C and 6B will be reduced by about five percent through land treatment. The estimated sediment yield to Site 8C will be reduced about ten percent by land treatment.

STRUCTURAL MEASURES

The installation of the structural measures will eliminate out-of-channel flooding, on the arroyos on which works of improvement are installed, from floods up to and including the one percent chance flood. Damage from larger floods will occur but were not evaluated. Structural measures control 87 percent of the total watershed area. Evaluated flood damages will be reduced by approximately 96 percent.

The areas protected from flooding by the structural measures are shown by evaluation units on the project map and the urban floodplain map.

All structural measures are planned to control at least the peak flows of a one percent chance of occurrence flood. The structures on Arroyos 2 and 3 (Sites 2A-1, 3C) will control flows from floods having a magnitude of as much as three times that of the one percent chance of occurrence flood.

There are three areas within the watershed that are not protected by the structural measures included in the plan. Arroyo 1 flows through the golf course where annual flows will cause damage. Below the golf course between Marie Street and the Rio Grande, Arroyo 1 has an existing channel which will control flows from a four percent chance storm before out-of-bank flooding begins. A second area, on which a feasible structural remedy was not found, is a very steep arroyo which empties into Arroyo 2 below U. S. Highway 85. This arroyo drains a small area located entirely within the city limits. This is a critical sediment source area, and it deposits significant sediment in Arroyo 2 and causes other localized damage. A third area of several short drainages located north of U. S. Highway 85 between Arroyos 5 and 6 is not included for structural control. The damage caused by these local drainages will be reduced because the backwater from Arroyos 5 and 6 will no longer contribute to flooding in this area.

The structural measures will reduce flood damage from floods such as the September, 1965 flood by nearly 100 percent on areas in the floodplain damaged by runoff from Arroyos 2, 3, 4, 5, 6, 7, and 8. A small amount of damage to the channels, road crossings and culverts would be the extent of the remaining damage. Floods comparable to the 1965 flood, occurring with the planned structural measures installed, would not damage urban property nor the irrigated cropland in the protected areas and would greatly reduce damage to roads, streets, and utilities.

The effects the installation of structural measures will have in reducing the area flooded by the one percent chance flood are shown in the tabulation on the following page.

The structural measures, when installed, will essentially eliminate sediment buildup on the floodplain of Mud Springs Canyon (Arroyo 8) and in all the arroyo channels, and on the fan below Site 3C. Future sediment yields from the watershed to the Rio Grande will be reduced by approximately 66 percent by both the land treatment and structural measures included in the plan.

The installation of structural measures will permit development of land for residential and commercial use. Approximately 220 acres

of land now flooded frequently or now subject to damage is idle. Some of this land, such as 135 acres below Site 3C, is advantageously located for urban development, except for the present flood danger. Another area that can be developed is above U. S. Highway 85 in the Williamsburg community. Choice highway frontage in both Truth or Consequences and Williamsburg is also idle because of the flooding.

Evaluation Unit and Site No.	Area Flooded by 1% Flood		Percent Reduction in Area Flooded
	Without Structures	With Structures	
Unit 1			
Site 2A-1	91 Acres	No overbank flooding on Arroyo 2	100.0
Unit 2			
Site 3C w/Channel 300 & Floodway 500	252 Acres	No overbank flooding	100.0
Unit 3			
Site 6B w/Channel 600 & Site 8C w/Channel 800	315 Acres	No overbank flooding	100.0
TOTAL	658 Acres	No overbank flooding	100.0

Approximately 135 acres in Evaluation Unit 2 below Site 3C and 60 acres below Site 8C in Evaluation Unit 3 can be developed after the structural measures are installed. The estimated increase in monetary value of land converted to residential and commercial use is $38,100 annually over the project life. These benefits are shown in Table 6 as changed land use benefits.

The areas of land on which a change in use will take place with the project are now flooded too frequently for development. These areas are the most suitable for future residential and commercial expansion because of their close proximity to existing development, level

topography, existing roads and utilties. Other available land is steep and rough and some is also above Interstate I-25, which makes it less accessible and farther removed from existing utilities.

The total area benefited by structural measures is 658 acres of which 84 are agricultural and the remaining is non-agricultural or urban. Essentially, all the benefited area is within the city limits of either Truth or Consequences or Williamsburg.

Approximately 2000 persons living in Truth or Consequences and Williamsburg will be directly benefited by the project.

Urban areas flooded and the depths of flooding by different frequency floods are shown in the tabulation on the following table.

Evaluation Unit No.	1 percent		4 percent		10 percent	
	Acres	Average Depth (Feet)	Acres	Average Depth (Feet)	Acres	Average Depth (Feet)
1	91	1.0	76	.8	65	.8
2	195	1.0	128	.8	98	.7
3	315	1.6	253	1.5	235	1.0
TOTAL URBAN AREA FLOODED	601	---	457	---	398	---

Approximately 300 homes in Truth or Consequences and Williamsburg will be protected by the installation of the project. In addition, 60 commercial or business properties, including motels, service stations, restaurants, garages, grocery stores, and miscellaneous retail establishments will be protected from flood damages.

Flood damage to urban property will be reduced by approximately 96 percent and damage to agricultural property by about 100 percent. Deposition of sediment from the watershed into the Rio Grande will be reduced by approximately 66 percent by the installation of the project.

PROJECT BENEFITS

LAND TREATMENT MEASURES

Benefits from the application of land treatment measures will include on-site conservation benefits which accrue from improved management of land and water resources. These on-site benefits were not evaluated in monetary terms.

Land treatment measures will provide off-site or downstream benefits by the reduction of sediment to the agricultural and urban areas. The estimated monetary value of sediment damage reduction benefits by land treatment is $4,700 annually.

STRUCTURAL MEASURES

Estimated average annual flood damage under future conditions without the project installed is $196,860. With the project installed, the estimated flood damage will be $8,260. This results in average annual damage reduction benefits of $188,600 from the installation of the project. The average annual damage reduction benefits to the structural measures include $110,350 for floodwater, $49,150 sediment, and $24,400 indirect damage reduction benefits.

In addition to damage reduction benefits, the structural measures will provide land enhancement benefits by a change in use. The estimated average annual benefits from changed land use for urban development is $38,100.

Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation and were not included in the benefit-cost analysis. Secondary benefits at the local level are significant and were used in the benefit-cost analysis. Secondary benefits at the local level were estimated to be 10 percent of the direct primary benefits and 10 percent of the estimated operation and maintenance cost of structural measures. The average annual secondary benefits which will accrue to the project are estimated to be $20,600.

The installation of the land treatment and structural measures will encourage additional interest in conservation of the resources of the watershed and will help stabilize the economy of this area. It will help and promote further capital, investment, increase employment, help maintain a higher standard of living, and contribute to the general welfare of the community. The installation of the project will reduce sediment deposition in Caballo Reservoir. These benefits were not evaluated in monetary terms.

COMPARISON OF BENEFITS AND COSTS

The estimated average annual benefits accruing to the structural measures are $242,600.

The estimated annual cost of the structural measures is $142,730 which includes $138,830 as the amortized installation cost and $3,900 as the average annual operation and maintenance costs (Table 4).

The ratio of average annual benefits of $242,600 to the average annual cost of the structural measures, $142,730, is 1.7:1 (Table 6). The ratio of benefits to costs without the inclusion of secondary benefits is 1.6:1.

PROJECT INSTALLATION

The work plan provides for a five-year installation period for the land treatment and a four-year period for the structural works of improvement. The project will be carried out under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666, as amended).

LAND TREATMENT

Land treatment measures will be established by farmers and ranchers on private and state land under the going programs. The Soil Conservation Service will provide technical assistance to landowners and operators through the Sierra Soil and Water Conservation District.

Installation of land treatment on the three sections of state-owned rangeland will be carried out by the lessees of the land under cooperative agreements with the Sierra Soil and Water Conservation District.

The Sierra Soil and Water Conservation District will encourage the development and application of conservation farm and ranch plans. The District will be responsible for providing leadership in an educational program to encourage the application of land treatment measures necessary for the success of the plan.

The Sierra Soil and Water Conservation District will obtain agreements from owners of not less than 50 percent of the land above each

floodwater retarding structure that they will carry out conservation ranch plans.

The installation of the structural measures will be the responsibility of Truth or Consequences and Williamsburg. Federal assistance will be provided to the local sponsors by the Soil Conservation Service under the provisions of Public Law 566, as amended.

A construction schedule agreed upon by the local organizations and the Soil Conservation Service is that the general sequence of installation will be Sites 8C, 6B, 3C, and 2A-1 with the associated outlet channels and one floodway.

The construction schedule will be adjusted on the basis of significant changes in the plan found necessary because of availability of funds and progress made.

Williamsburg will be responsible for the installation of Site 8C and Channel 800.

Truth or Consequences will be responsible for the installation of Sites 2A-1, 3C, 6B, Channels 300 and 600, and Floodway 500.

The following minimum conditions shall be met before issuance of invitations to bid on any construction unit:

1. All necessary land rights must be obtained for a construction unit. Land rights include relocation of roads, houses, bridges, fences, utilities, land acquisition or easements and rights-of-way on the needed land.

   Truth or Consequences and Williamsburg have the power of eminent domain and agree to use such authority if necessary. Therefore, federal assistance for construction may be provided when all land rights for a construction unit are obtained.

2. Mutual agreements on the schedule for construction and on plans and specifications shall be reached. Terms of contracts and all matters pertaining to contracts or to works of improvement shall be mutually satisfactory and in accordance with requirements of the sponsors and in agreement with the Soil Conservation Service technical and administrative requirements.

3. Full conformance with state and federal laws and regulations shall be the responsibility of the sponsors and shall be secured with no expenditure of PL-566 funds. Reasonable evidence of conformity shall be presented to the mutual satisfaction of all parties.

The Soil Conservation Service will provide technical assistance in making detailed surveys, geologic investigation, detail designs, preparation of plans and specifications, supervision of construction, preparation of contract payment estimates, awarding contracts, contract administration, final inspection, certification of completion, and other related work. The sponsoring local organizations have formally requested the Soil Conservation Service to administer all the construction contracts.

The Soil Conservation Service will provide construction funds for the four floodwater retarding structures, two outlet channels, one outlet (drain pipe), and one floodway.

FINANCING PROJECT INSTALLATION

The cost of land treatment measures to be applied on private and state lands will be borne by farmers and ranchers. Cost-sharing assistance, on those measures eligible for assistance, will be available through the Agricultural Conservation Program.

The cost of carrying out range proper use on federal land will be from regular funds of the Bureau of Land Management.

The city of Truth or Consequences and the village of Williamsburg have authority under state law to levy assessments on real property, borrow such money as necessary, and acquire needed land rights and to carry out their responsibilities in the installation of the project. Truth or Consequences and Williamsburg will make an application to Farmers Home Administration for a loan estimated to be $174,000 to assist them in carrying out their responsibilities.

Federal financial assistance in carrying out the project will be made available to the local organizations when the necessary land rights are obtained and when federal funds are available. Federal funds are contingent on appropriations made under Public Law 566.

PROVISIONS FOR OPERATION AND MAINTENANCE

LAND TREATMENT MEASURES

The land treatment measures will be maintained by landowners and operators on private and state lands.

STRUCTURAL MEASURES

Representatives of the sponsoring local organizations and the Soil Conservation Service will make a joint inspection of the structural measures annually and after each major flood for three years following the installation of each structure. The inspections will be made to determine the need for maintenance and repair, and if required, when maintenance and repair will be accomplished.

Inspections after the third year will be made annually by the sponsors and a report prepared by them. A copy of the report will be furnished to the Soil Conservation Service and the New Mexico State Engineer.

Maintenance of the structural measures shall include, but not be limited to:

1. Keeping all structures in serviceable condition by making replacements and repairs as needed.

2. Maintaining adequate capacity in natural and constructed channels by controlling weeds and undesirable tree growth, removal of sediment accumulation, and removal of debris jams.

3. Damage to the structural measures caused by large storms will be repaired by the local sponsors as part of the maintenance program.

The operation and maintenance of the structural measures will be the responsibility of Truth or Consequences and Williamsburg. The division of operation and maintenance responsibility between the two sponsors is as follows:

Williamsburg will have full responsibility of operation and maintenance of floodwater retarding structure 8C and Channel 800. The

estimated average annual operation and maintenance cost to Williamsburg is $2,450.

Truth or Consequences will operate and maintain floodwater retarding structures 2A-1, 3C, 6B, Channels 300 and 600, and Floodway 500. The estimated average annual cost of operation and maintenance to Truth or Consequences is $1450.

Total average annual operation and maintenance cost for the structural measures included in the plan is $3,900 (Table 4).

An operation and maintenance agreement must be executed before a project agreement is signed.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

T or C - Williamsburg Arroyos Watershed, N.M.

Installation Cost Item	Unit	Number			Estimated Cost (Dollars) 1/						TOTAL
					P. L. 566 Funds			Other Funds			
		Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	
Land Treatment											
Soil Conservation Service											
Cropland	Acre		84	84					11,700	11,700	11,700
Rangeland	Acre		3,677	3,677					17,500	17,500	17,500
Technical Assistance						9,100	9,100		3,900	3,900	13,000
SCS Subtotal			3,761	3,761		9,100	9,100		33,100	33,100	42,200
Bureau of Land Management											
Rangeland	Acre	11,350		11,350				2,500		2,500	2,500
TOTAL LAND TREATMENT		11,350	3,761	15,111		9,100	9,100	2,500	33,100	35,600	44,700
Structural Measures											
Construction											
Soil Conservation Service											
Floodwater Retarding Structures	No.		4	4		1,593,900	1,593,900				1,593,900
Channels and Pipeline	Ft.		5,160	5,160		243,200	243,200				243,200
Floodway	Ft.		2,965	2,965		214,400	214,400				214,200
Subtotal - Construction						2,051,500	2,051,500				2,051,500
Engineering Services											
Soil Conservation Service						154,000	154,000				154,000
Project Administration											
Soil Conservation Service											
Construction Inspection						176,300	176,300				176,300
Other Costs						135,200	135,200		1,600	1,600	136,800
Subtotal - Project Administration						311,500	311,500		1,600	1,600	313,100
Other Costs											
Land Rights									172,500	172,500	172,500
TOTAL STRUCTURAL MEASURES						2,517,000	2,517,000		174,100	174,100	2,691,100
TOTAL PROJECT						2,526,100	2,526,100	2,500	207,200	209,700	2,735,800
Summary											
Subtotal SCS						2,526,100	2,526,100		207,200	207,200	2,733,300
Subtotal BLM								2,500		2,500	2,500
TOTAL PROJECT						2,526,100	2,526,100	2,500	207,200	209,700	2,735,800

1/ Price Base 1969

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(At Time of Work Plan Preparation)

T or C-Williamsburg Arroyos Watershed, New Mexico

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
Land Treatment			
Pasture and Hayland Management	Acre	38	100
Pasture and Hayland Planting	Acre	59	500
Land Leveling	Acre	38	2,700
Irrigation Systems	No.	3	2,400
Proper Grazing Use	Acre	6,120	3,000
Water Developments	No.	13	13,000
Contour Furrowing	Acre	640	1,280
Structural Measures			
Detention Dams	No.	6	50,000
Levees, Dikes and Bank Protection Works	---	---	33,000
TOTAL	---	---	105,980

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1/ Price Base 1969

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

T or C - Williamsburg Arroyos Watershed, New Mexico

(Dollars) 1/

Item	Installation Cost - PL-566 Funds			Inst. Cost - Other		Total Installation Cost
	Construction	Engineering	PL-566 Total	Land Rights	Total Other	
Floodwater Retarding Structures:						
Site 2A-1	176,400	15,900	192,300	40,000 2/	40,000	232,300
Site 3C	148,600	13,400	162,000	53,500 3/	53,500	215,500
Site 6B	208,900	18,800	227,700	25,700	25,700	253,400
Site 8C	1,060,000	63,600	1,123,600	7,700 4/	7,700	1,131,300
Channels						
300	58,600	5,900	64,500	8,800 5/	8,800	73,300
600	35,800	3,700	39,500	4,300 6/	4,300	43,800
800	148,800	13,400	162,200	10,000	10,000	172,200
Floodway						
500	214,400	19,300	233,700	22,500 7/	22,500	256,200
Subtotal	2,051,500	154,000	2,205,500	172,500	172,500	2,378,000
Project Administration	---	---	311,500	---	1,600	313,100
GRAND TOTAL	2,051,500	154,000	2,517,000	172,500	174,100	2,691,100

1/ Price base: 1969
2/ Includes $7,000 for removal and relocation of house
3/ Includes $1,000 for road relocation
4/ Includes $2,000 for road relocation
5/ Includes $6,700 for culverts under roads and streets and $500 for crossing utility lines.
6/ Includes $800 for culverts under roads and streets and $500 for crossing utility lines.
7/ Includes $19,000 for culverts under roads and streets and $500 for crossing utility lines.

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TABLE 3 - STRUCTURAL DATA

STRUCTURES WITH PLANNED STORAGE CAPACITY

T or C-Williamsburg Arroyos Watershed, New Mexico

ITEM	UNIT	STRUCTURE NUMBER				TOTAL
		2A-1	3C	6B	8C	
Class of Structure		c	c	c	c	---
Drainage Area						
Controlled	Sq. Mi.	1.12	1.29	1.04	20.4	23.85
Curve No. (1-day) (AMC II)		85	85	85	85	---
Tc	Hrs.	0.66	0.5	0.36	6.0	---
Elevation Top of Dam	Ft.	4327.7	4365.3	4341.2	4475.0	---
Elevation Crest Emergency Spillway	Ft.	4324.3	4362.9	4331.5	4458.0	---
Elevation Crest High State Inlet	Ft.	4305.1	4351.0	4331.5	---	---
Elevation Crest Low Stage Inlet	Ft.	4294.5	4344.7	4325.0	4440.2	---
Maximum Height of Dam	Ft.	62.9	38.7	37.4	82.5	---
Volume of Fill	Cu. Yds.	186,800	160,800	184,000	967,800	1,499,400
Total Capacity	Ac. Ft.	504	620	196	1,714	3,034
Sediment Aerated	Ac. Ft.	74	104	100	771	1,049
Retarding	Ac. Ft.	430	516	96	943	1,985
Between High and Low Stage	Ac. Ft.	100	126	96	---	322
Surface Area						
Sediment Pool	Acres	6.9	14.8	12.3	39	73.0
Retarding Pool	Acres	23.5	43.0	17.0	68	151.5
Principal Spillway						
Rainfall Volume (areal) (1 day)	In.	3.4	3.4	3.4	3.3	---
Rainfall Volume (areal) (10 day)	In.	6.0	6.0	6.0	5.92	---
Runoff Volume (10 day)	In.	3.0	3.0	3.0	3.21	---
Capacity of Low Stage (Max.)	cfs.	20	15	16	---	---
Capacity of High Stage (Max.)	cfs.	162	144	128	370	---
Frequency Operation-Emer. Spillway	% Chance	0.1	0.1	1.0	1.0	---
Size of Conduit	Dim.	30	30	30	3' x 4'	---
Emergency Spillway						
Rainfall Volume (ESH) (areal)	In.	10.0	10.0	10.0	8.30	---
Runoff Volume (ESH)	In.	8.16	8.14	8.14	6.50	---
Type		Earth*	Earth*	Conc.	Conc.	---
Bottom Width	Ft.	110	200	40	100	---
Velocity of Flow (Ve)	Ft/Sec.	0	0	---	---	---
Slope of Exit Channel	Ft/Ft.	0.25	0.3	0.33	0.33	---
Maximum Water Surface Elevation	Ft.	4324.3	4362.9	4337.0	4469.3	---
Freeboard						
Rainfall Volume (FH) (areal)	In.	16.0	16.0	16.0	13.28	---
Runoff Volume (FH)	In.	14.06	14.06	14.06	11.30	---
Maximum Water Surface Elevation	Ft.	4327.7	4365.3	4341.2	4475.0	---
Capacity Equivalents						
Sediment Volume	In.	1.24	1.51	1.80	0.71	---
Retarding Volume	In.	7.19	7.38	1.46	0.88	---

* Control Section Lined with Soil Cement

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TABLE 3A - STRUCTURE DATA

CHANNELS

T or C-Williamsburg Arroyos Watershed
New Mexico

Name and Number	Station or Reach	Drainage Area Sq. Mi.	Capacity cfs		Water Surface Elev.	Hydraulic Gradient (Ft./Ft.)	Channel Dimensions			"n" Value		Velocities1/		Excavation Cu.Yds.	Type of Improvement2/
			Req'd	Design			Bottom(ft)	Depth(ft)	Side Slopes	Aged	As Built	Aged	As Built		
Channel 300	62+00 72+30	0.22	329	409[3/]	4267.6[4/]	0.016	7.0	3.3	0	.015	.015	16.8	16.8	2030	L
Channel 300	72+30 72+80	0.22	329	409[3/]	4250.3[4/]	0.016	7.0	3.3	0	.015	.015	16.8	16.8		L 5/
Floodway 500	64+20 70+40	0.18	325	627[3/]	4267.0[4/] 4250.93	0.259	10.0	2.7	0	.015	.015	18.6	18.6		L 6/
Floodway 500	70+40 77+80	0.40	667	772[3/]	4250.93 4245.5[4/]	0.008	10.0	4.8	0	.015	.015	15.5	15.5		L 6/
Floodway 500	77+80 93+85	0.50	706	816[3/]	4245.5 4232.7[4/]	0.008	10.0	5.0	0	.015	.015	15.7	15.7		L
Outlet 600 (Drainage Pipe)	9+42 23+82	0	16	20	---	0.0368	18 inch diameter			.013	.013	11.3	11.3		Pipe
Channel 800	134+30 150+30	0.54	800	1040	---	0.018	50	5.0	3:1	.030	.030	9.6	9.6	dike 14,000	E
Channel 800	150+30 151+30	0.71	900	1350	---	4 - 6'x8' existing box culverts under U. S. Highway 85									
Channel 800	151+30 161+30	0.71	900	1350	---	0.008	10	5.1	1½:1	.015	.015	15	15	5,000	L

1/ Where excavation is not planned, show cross sectional area and wetted perimeter below hydraulic grade line.

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2/ C & S - Clearing and Snagging
CE - Channel Enlargement
L - Lined Channel
E - Earth Channel

3/ Capacity to top of lining.

4/ Elevation at required capacity.

5/ Covered Channel.

6/ Covered Channel Station 70+15 to 71+15.

TABLE 3B - STRUCTURE DATA

GRADE STABILIZATION STRUCTURES

T or C-Williamsburg Arroyos Watershed, New Mexico

Site No.	Drainage Area	Drop	Concrete	Type of Structure
	(Sq. Mi.)	(Feet)	(Cu. Yd.)	
501	0.009	4.0	3	Entrance
505	0.06	2.0	5	Entrance
507	0.5	4.0	40	Outlet
601	P. S. Discharge			Pipe Inlet
602	P. S. Discharge			Pipe Inlet
801	P. S. Discharge	10.0	109	Std. Drop
802	0.54	10.0	138	Std. Drop
803	0.71	5.0	103	Outlet

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TABLE 4 - ANNUAL COST

T or C-Williamsburg Arroyos Watershed, New Mexico

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	Operation and Maintenance Cost	Total
1 - Site 2A-1	11,980	300	12,280
2 - Site 3C w/Channel 300 and Floodway 500	28,120	750	28,870
3 - Site 6B w/Channel 600 and Site 8C w/Channel 800	82,580	2,850	85,430
PROJECT ADMINISTRATION	16,150	---	16,150
GRAND TOTAL	138,830	3,900	142,730

1/Price base: Installation - 1969 cost; O&M Adjusted Normalized Prices (Rounded to nearest $10)

2/100-years @ 5 1/8 percent interest (Rounded to nearest $10)

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

T or C-Williamsburg Arroyos Watershed, New Mexico

(Dollars) 1/

Item	Estimated Average Annual Damage 2/ Without Project	With Project	Damage Reduction Benefit
Floodwater			
Agricultural			
Crop and Pasture	400	0	400
Other Agricultural	180	0	180
Nonagricultural			
Residential	88,350	1,650	86,700
Commercial	21,590	1,650	19,940
Highways, Roads, Streets	550	90	460
Utilities	1,320	100	1,220
Existing Flood Control Structures	1,550	100	1,450
Subtotal	113,940	3,590	110,350
Sediment			
Agricultural			
Crop and Pasture	230	0	230
Nonagricultural			
Residential	37,830	620	37,210
Commercial	9,260	650	8,610
Highways, Roads Streets & Existing Channels, Dams, etc.	6,300	900	5,400
Rio Grande	3,600	1,200	2,400
Subtotal	57,220	3,370	53,850
Indirect	25,700	1,300	24,400
Total	196,860	8,260	188,600

1/ Price Base: Adjusted Normalized Prices

2/ Damage from floods larger than the 1 percent chance of occurrence flood was not evaluated.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

T or C-Williamsburg Arroyos Watershed, New Mexico

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS 1/				Average Annual Cost 3/	Benefit Cost Ratio
	Damage Reduction	Changed Land Use (Urban)	Secondary	Total		
1 - Site 2A-1	40,700	---	3,600	44,300	12,280	3.6:1
2 - Site 3C - w/Channel and Floodway 500	7,000	26,200	3,300	36,500	28,870	1.3:1
3 - Sites 6B, 8C w/Channels 600, 800	136,200	11,900	13,700	161,800	85,430	1.9:1
Project Administration	---	---	---	---	16,150	---
GRAND TOTAL	183,900 2/	38,100	20,600	242,600	142,730	1.7:1

1/ Price Base: Adjusted Normalized Prices

2/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $4,700 annually.

3/ From Table 4

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TABLE 7 - CONSTRUCTION UNITS

T or C-Williamsburg Arroyos Watershed, New Mexico

(Dollars) 1/

Measures in Construction Unit	Annual Benefit	Annual Cost
1 - Site 2A-1	44,300	12,280
2 - Site 3C w/Channel 300 Floodway 500	36,500	28,870
3 - Site 6B w/Channel 600 and Site 8C w/Channel 800	161,800	85,430

1/ Price Base 1969

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INVESTIGATIONS AND ANALYSES

ENGINEERING

A study of past floods, aerial photographs, and U. S. Geological Survey topographic quadrangles showed eight arroyos were the principal causes of flooding from runoff outside of the urban areas. Possible methods of structural control were located by considering topography, urban development, and the degree of control afforded by the structures.

Eighteen floodwater retarding structure sites and seven outlet channels were tentatively located and surveyed. Three channels were studied. One diversion was surveyed.

The following surveys were made to develop data for the detailed planning of the structural measures in this plan:

1. Differential level surveys to establish mean sea level elevations at each proposed structure site.

2. Plane table alidade topographic surveys with 4-foot contour intervals of the reservoir sites.

3. Differential level surveys to establish the profile and prepare cross-sections of the channel and their floodplains.

Elevation storage curves were made from the topographic maps of the reservoir sites for proportioning and flood routing.

The floodwater retarding structures were planned using the limiting criteria for proportioning earth dams and associated spillways as set forth in Engineering Memorandum SCS-27 (rev.), Earth Dams, March 19, 1965, as supplemented. The open channels were planned using SCS-Technical Release 25 as a guide.

Cost estimates were based on the quantity estimates from preliminary designs and the current unit prices for similar work in this locality. Where local cost information was not available, costs for similar construction in other areas were used after being adjusted to the local conditions.

All structural sites and the diversion were determined to have a hazard classification of "c" due to the potential loss of life and damage to valuable property in case of structural failure. The channels were planned to contain flood flows from the one percent chance of occurrence flood.

The sponsors requested control of Arroyo 1 be deleted from the plan because: the structures at the two sites available did not give a high percent of control and they would also be in the way of a proposed roadway under Interstate Highway I-25; channeling would be too costly because of the necessity for enlarging a 400-foot box culvert which passes under a privately-owned auto service shop and U. S. Highway 85.

On Arroyo 2, eight dam sites, channeling and diversion into Arroyo 3 were considered. The channel diversion and several sites were discarded because they were either unfeasible or did not give adequate control. Cost analyses were made on the remaining sites, including evaluation of combinations of different-sized principal spillways, concrete chute spillways, auxiliary earth spillways, and storage of the emergency spillway hydrograph. A floodwater retarding structure at Site 2A-1, was chosen because it gives the greatest control at the least cost.

On Arroyos 3 and 4, five different dam sites were investigated. A site in each arroyo was abandoned in favor of a lower site which would control both arroyos. Cost analyses were made on the remaining three sites including evaluation of combinations of different-sized principal spillway hydrograph. A structure at Site 3C was chosen because it gives the greatest control at the least cost.

An evaluation and cost analysis was made on the only feasible dam site on Arroyo 5. This site was abandoned because of urban development in and below the location for an emergency spillway. Floodway 500 was then evaluated making use of the diversion and culvert being installed as a part of the new highway, U. S. 85. Also, this floodway will join with Channel 300, eliminating about 2370 feet of Channel 300.

On Arroyos 6 and 7, three dam sites and channeling were considered. The two lower sites, each of which will control both arroyos, were evaluated. Analyses were made on combinations using different-sized principal spillways, and emergency spillways alone and in combination. Site 6B was decided upon because it gives the greatest control, the retarding pool does not endanger Interstate Highway I-25, and it is the least costly method of control.

On Arroyo 8, four sites and channeling to the Rio Grande were considered. Sites 8, 8B, 8C, and the channel were evaluated. The channel was eliminated because of limited right-of-way through the village of Williamsburg and it would carry sediments into the Rio Grande which would require removal. Large flows could block the river, causing flooding in parts of Williamsburg. Site 8 was located at a ranch headquarters and ranch water facilities and corrals were located in the pool area. Therefore, it was abandoned. Site 8C was chosen because of its more desirable location. It will give the desired control.

Alternatives included in the evaluations were combinations of different-sized principal spillways, different sizes of concrete chute emergency spillways, and auxiliary earth spillways.

Stability studies were made on all outlet channels using clear water where stabilization was needed; grade stabilization structures were considered as first choice, then rip-rap, channel lining, and pipe. The least costly method which would give the desired control without excessive maintenance was used.

The outlet channels below the four planned floodwater retarding structures and Floodway 500 were analyzed to determine if their capacity was adequate to convey the principal spillway discharge plus the one percent chance flows from the intervening areas to the Rio Grande. Where channel capacities were adequate, stability studies were made using the tractive force method. Where stabilization was needed, the first consideration was drop structures to reduce the grades. Where steep grades and erosive materials existed, channel linings and pipelines were evaluated. Costs, including operation and maintenance, were the principal factor considered in determining the type of outlet channel planned. From these analyses, it was determined to line with concrete Channel 300 and Floodway 500, install a pipeline in Outlet 600, and use a combination of drops and concrete lining in outlet Channel 800.

HYDROLOGY INVESTIGATIONS

GENERAL

Hydrologic studies were primarily concerned with: (1) Determining the present and with project peak flow evaluation series for use in developing area-inundated frequency relationships and floodwater diversion design capacities; (2) Developing volume-duration frequency relationship for estimating capacity of the proposed floodwater detention structures; (3) Developing emergency spillway design hydrographs for proportioning and estimating capacities for emergency spillways.

BASIC DATA

The average annual precipitation is 8.5 inches. Damaging storms generally occur from June through September. Snowfall occurs very seldom in the watershed. Snow that does fall will melt within a few days with very little or no resulting runoff.

Flooding characteristically results from high-intensity, short duration thunderstorms with resultant high discharge rates and small volumes of flow. Peak rates of runoff are significantly affected by short times of concentration due to steep watershed slopes and sparse vegetative cover which offers little resistance to overland flow.

There are no stream gaging stations within the watershed or in nearby watersheds having similar topographic and hydrologic characteristics. There is one precipitation gage located in the lower end of the watershed and two others within five miles. These records were of short duration, or because of geographic location, not representative of storms that occur on the watershed.

Rainfall amounts obtained from rainfall frequency maps recently prepared by the U. S. Weather Bureau (Revised T.P. 40 maps prepared in June, 1967) were used as a basis for developing evaluation storm series.

A generalized soil survey was made for the watershed. This soil survey, along with a field investigation was used to determine Curve Numbers (CN) to be used in determining runoff. Curve numbers varied from 68 in gravel bottoms to 90 on steep rock outcrops and were weighted to obtain an average curve number for each drainage.

Land treatment was not considered to have a significant or measurable effect on future runoff. This is because vegetative cover in this low rainfall zone, even at optimum, would still be in hydrologically poor condition.

EVALUATION

Hydrologic and hydraulic data on past floods were gathered from local residents, old newspapers and special flood reports. The rainfall and duration data was used to establish the frequency of some of the larger reported floods. The duration of past storms was usually less than one hour.

The synthetic storm series for evaluation was developed as follows: Precipitation for different durations and frequencies of storms were developed by taking the 24-hour precipitation for different frequencies from Revised T.P. 40 maps. Based upon local observations of characteristics of historical storms and generalized characteristics of storms experienced in the Rio Grande Valley, the 1-hour duration storm was estimated to be approximately 85 percent of the 24-hour storm volume. Using this relationship on a log plotting permitted interpolation of rainfall amounts for durations between 1 and 24 hours.

Peak flow for the large drainage, Mud Springs Canyon, was calculated by procedures in Chapter 21, Section 4, NEH. Peak flows on the small drainages were determined using Part 3, Estimated Rates of Runoff, Engineering Handbook for Work Unit Staffs, Arizona, January, 1963.

Area and depths of inundation were determined by channel routing using the Manning formula to determine channel capacity in the few places where streams were confined. Where unconfined, the alluvial fan flow charts developed for use on this watershed were used. Maps and tables showing depth and area flooded when no structural works are installed were developed for the 100, 25, and 10-year flows. Also, evaluations were made assuming structures in place.

DESIGN HYDROGRAPHS

Principal spillway hydrographs were developed using the procedure in Chapter 21, NEH, Section 4, Hydrology. The 1-day (24-hour) point rainfall of 3.4 inches was estimated from revised T.P. 40 maps, June, 1967. The 10-day point rainfall of 6.0 inches was estimated from U. S. Weather Bureau Technical Paper 49. The hydrographs were developed by the computer using the DAMS program.

Emergency spillway design hydrographs and freeboard hydrographs were developed, using the method of Chapter 21, NEH-4, Hydrology. Hydrographs for design were determined using criteria outlined in Engineering Memorandum SCS-27 (rev.).

Emergency spillway design rainfall exceeds minimum criteria of SCS Engineering Memorandum 27. Probable maximum precipitation which was used to develop the freeboard hydrograph was obtained from a special study of the Rio Grande Valley made by the Weather Bureau in 1967.

Peak flows from uncontrolled areas entering channels were based on the 1 percent, 1-hour point rainfall of 2.9 inches, using the Arizona Method.

ROUTINGS

The reservoirs were routed by the computer using the DAMS program, except the freeboard routing of Sites 2A-1, and 3C, by U. D. Method of Reservoir Flood Routing, TR-35.

In Structures 2A-1, and 3C, the entire emergency spillway design hydrograph was stored and released through the principal spillway. Structures 6B and 8C have concrete chute spillways to pass both the emergency spillway hydrograph and the freeboard hydrograph.

SEDIMENT AND RELATED INVESTIGATION

Field investigations pertaining to sediment problems in the watershed were conducted in accordance with standard procedures of the Soil Conservation Service. Computations indicate sediment yields to structures range from 0.4 to 1.0 acre feet per square mile per year. Sediment from the upper reach of Site 8 was determined by measured yield at a stock tank. That of the lower reach was computed by the arid regions predictive equation.

CHANNEL STABILITY INVESTIGATION

Field investigations were conducted consisting of engineering surveys of cross sections and stream profiles with sampling of bottom and bank materials. Laboratory analysis of samples and evaluation using the Tractive Force method indicates grade materials in Channel 800 will scour only five inches before stabilizing. All other channels planned are of reinforced concrete.

GEOLOGIC INVESTIGATIONS

A preliminary investigation has been made at each proposed site using reconnaissance methods with the aid of a pick-up truck mounted power auger.

In general, Sites 2A-1, 3C, and 6B are underlain at depth by Paleozoic rocks. These rocks are folded, fractured and faulted, and are steeply dipping, being located at the apex of an eroded, overturned anticline. These basement rocks are overlain by horizontally lying beds of Santa Fe Age. Foundations consist of bentonitic clay which, because of the manner of its deposition, can be considered to be very widespread. This clay outcrops at the base of the abutments and is overlain by dense, stratified beds of silty sand and gravel, in places cemented by carbonate. All abutments are capped by massive loose silty gravelly sand. At all sites, the earth fill of the structure

can be keyed into Santa Fe Age strata. The bentonitic clay has been laboratory tested and possible problems presented have been considered in planning design and cost estimates.

Site 2A-1 is underlain by bentonitic clay. The clay is exposed in the channel bottom and extends laterally under the right abutment. The clay was not reached in shallow drill holes in the alluvial fill of the mid-arroyo bottom. The abutments are alluvial fill consisting of silty sand overlying dense sandy and gravelly Santa Fe Age stratification. Prolonged emergency flow on this material may result in damage; therefore, the emergency spillway hydrograph will be passed through the principal spillway. The pool area immediately upstream of the proposed centerline consists of stratified clean sand with gravel. Ample suitable material is available at the site for construction.

Site 3C is underlain by gravelly silty sand to a depth of more than 19 feet. Bentonitic clay similar to that of Site 2A is believed to underlie this alluvial fill. The abutments consist of clay at the base, Santa Fe beds, and silty sand similar to that found at Site 2A-1. The materials underlying the pool area are similar to that of the foundation. Adequate low-to-high plasticity clay is available at the site for construction of an impervious core. The gravelly silty sand of the pool area is adequate for fill in the outer shell of the structure.

Site 6B is underlain by bentonitic clay. The clay is exposed in the abutments and the central ridge separating Arroyos 6 and 7. This clay is overlain by gravelly sand possibly no greater than 12 feet in thickness. The abutments consist of silty clay at the base overlain by indurated silt and silty sand of Santa Fe Age. Both abutments are capped by silty sand similar to that at Sites 2A-1 and 3. The pool area is underlain by similar sandy bentonitic clay as is the foundation. Adequate low-to-high plasticity clay is available from the central ridge for backfill and an impervious core in the dam. The silty gravelly sand of the pool area is adequate to construct the outside shell. Laboratory tests were made on the bentonitic clay borrow material at this site. Any problems presented were considered in planning design and cost estimates.

Site 8C is underlain by modern alluvium to an estimated depth of 40 feet and consists of dense stratified stream channel deposits of gravel, sand, silt and clay presenting a low degree of potential consolidation as foundation materials. The abutments consist of relatively impervious clay, silty clay with gravel and minor silt lens. The pool area is underlain, near the surface, by silty and gravelly sand and at depth is similar to the foundation materials. Borrow, for backfill of the core of the dam, is available from the lower slopes

of the pool area at the right side. The outer shell of the dam can be constructed of the surface silty, gravelly sand from the pool area and from tributary channel mouths.

ECONOMIC INVESTIGATIONS

DETERMINATION OF DAMAGES

Agricultural land subject to damage from floods up to and including the one percent chance floods is about 84 acres of irrigated land. Damage information was obtained on the 1948, 1950, 1965, and 1967 floods.

All known local sources of information on flood damage were contacted, including individual property owners, state and county road officials, and officials in Truth or Consequences and Williamsburg. The files of the local newspaper were examined for dates of floods, amounts of rainfall reported, areas of damage, and other pertinent information.

The damageable value for crops and pasture grown in the watershed was determined from information on crop yields obtained from landowners and cost-return data developed in the general area by the Soil Conservation Service. From the damageable value for the crops grown in the floodplain, a crop damage factor was determined. The crop damage factor reflects loss from reduction in crop yields, damage to quality, increased production cost, increased maintenance cost, and other agricultural losses.

Average annual crop and pasture damage was determined by using the "peak discharge-area inundated relationship" developed in the hydrologic analysis. This analysis developed by the hydrologist includes storms or floods up to and including the one percent chance storm.

Application of the crop damage factor to acres flooded by depth increments to all storms in the evaluation series determined the average annual crop and pasture damage. The price base used in the evaluation is the adjusted normalized prices contained in the Interim Price Standards.

Damage to agricultural property is about three percent of the average annual damage in the watershed.

Non-agricultural damage occurs to urban areas in Truth or Consequences and Williamsburg. Floods damage residential and commercial

property, roads, streets, utilities, and works of improvement now existing on the major drainages.

Flood damage information was obtained on the 1950, 1965, and 1967 floods. Individual owners of homes and business establishments, local officials, realtors, and local contractors were interviewed to obtain estimates on flood damages.

Evaluation of damages for future conditions of development were made. Analysis made by the hydrologist established areas flooded and depths of flooding in each evaluation unit. This analysis included the 10, 4, and 1 percent chance of occurrence floods.

Residential damage estimates were made for expected future level of development. The studies made included an inventory of existing residential developments, type of construction, floor heights above ground, market value of homes and contents, and other pertinent data. Local realtors and local contractors were interviewed to establish market value of homes.

Flood damage to residential property was estimated by using damage information secured on the 1965 and 1967 floods. For depths of flooding in excess of those reported, the values in the report made by Stanford Research Institute entitled "A Study of Procedures in Estimating Commercial, Residential and Industrial Properties in California", were used.

Damage information to commercial property was obtained on the 1965 and 1967 floods. However, the information available is limited, as those floods did not damage many different types of commercial property, nor was the damage information complete due to change in ownership and other factors.

An inventory of existing commercial property located within the areas that would be flooded by the one percent chance of occurrence flood was made. This inventory established types of construction, value per square foot of buildings, value of fixtures, and values of inventories by type of business. This information was adjusted to account for future development. From this basic data, the expected value per acre of land in commercial property was computed.

Flood damage estimates to commercial property for future conditions of development were made by applying the damage factors to outside depths of flooding. Damage factors or dollar damage per $1000 of value were obtained from Figure 21 in the report by Stanford Research Institute on estimated flood damage to commercial property.

Flood damage to roads, streets, U. S. Highway 85, utilities, and to existing flood control measures for the 1965 and 1967 floods was obtained from officials in Truth or Consequences, Williamsburg, state and county road officials and local property owners.

Average annual flood damage to urban property was adjusted to the Normalized Price Index (U. S. Department of Commerce Construction Cost Index). The final dollar damage to urban property was derived by application of the personal income factor to account for expected increases in damageable values due to higher personal income.

Sediment deposition in the Rio Grande for future conditions without the project and with the project in place was evaluated. This evaluation was based upon the estimated acre-feet of sediment which the geologist made for the two conditions and the cost of sediment removal by use of a dragline. Cost per cubic yard represents current cost adjusted to normalized prices.

Some sediment will be carried into Caballo Reservoir which is located a few miles below the watershed. These damages were not evaluated.

FLOOD DAMAGE REDUCTION BENEFITS

Flood damage reduction benefits were determined as the difference between future damages without and with the project. Physical damages were converted to monetary terms and their reduction credited as project benefits.

CHANGED LAND USE BENEFITS - (URBAN)

The installation of the project will afford a high degree of protection on undeveloped lands in Truth or Consequences and Williamsburg. These lands are now flooded and covered with sediment to an extent that they are vacant and idle. With the project installed, these areas will become preferred commercial and residential sites. Approximately 195 acres will be developed for residential use, and 4200 feet of highway frontage will be developed for commercial use with the project installed.

Several meetings with Truth or Consequences City Commission and with the City Planning and Zoning Board were held to identify lands which would have a change in use as a result of the project. Also, estimates of the present value without the project and the enhanced value with the project were discussed. The period of time or delay before these lands would be developed was discussed. These discussions led to

mutual agreement on the areas that would be enhanced, the use of the area, the enhanced value, and the probable period of time over which development will take place.

The project benefits on the increased value of land for residential and commercial development were taken after deducting associated cost for development and discounted for a 10-year lag in the area below Sites 6B and 8C and for a 15-year lag below Site 3C.

The basis for projecting changes in land use due to the installation of the project include studies made during the development of the work plan. The results of these studies including the investigations, findings and conclusions are the basis for claiming benefits for land use changes.

County projections by the Bureau of Business Research (University of New Mexico) indicate an increase of approximately three percent per year in Sierra County, from 1970 to 1990, and by the year 2000 the population in the county is projected to be three times the 1960 population. Approximately two-thirds of the county population is in Truth or Consequences and Williamsburg.

The studies made and the growth pattern since 1960 indicated the projected development of 195 acres of land in the project area of Truth or Consequences over the next 15 years is reasonable.

SECONDARY BENEFITS

Secondary benefits, which represent the net increase in value of goods and services, stemming from the project will be realized by local residents and business firms in the community and trade area. These secondary benefits were calculated to be 10 percent of the primary benefits excluding indirect benefits.

Secondary benefits induced by the project were calculated to be 10 percent of the estimated average annual cost of operation and maintenance of project works of improvement.

METHODS AND PROCEDURES

Details of the procedures used in the investigation and analysis are described in the Economics Guide for Watershed Protection and Flood Prevention.

FISH AND WILDLIFE INVESTIGATIONS

The U. S. Fish and Wildlife Service made a reconnaissance of the Watershed to determine the feasibility of developing recreation as a project purpose.

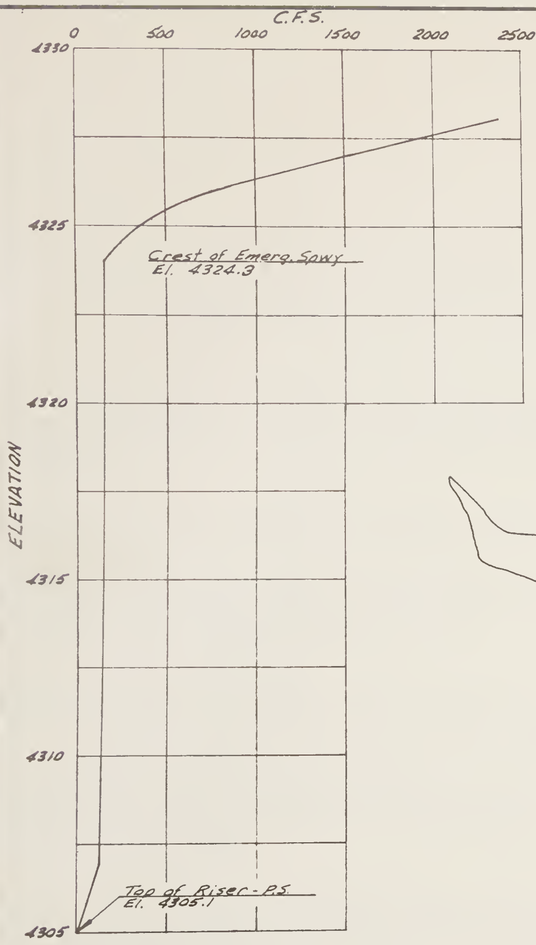
A portion of their report is as follows:

"The absence of any water in the arroyos except during flood periods precludes stream fishing in the watershed. This condition is not expected to change with the project.

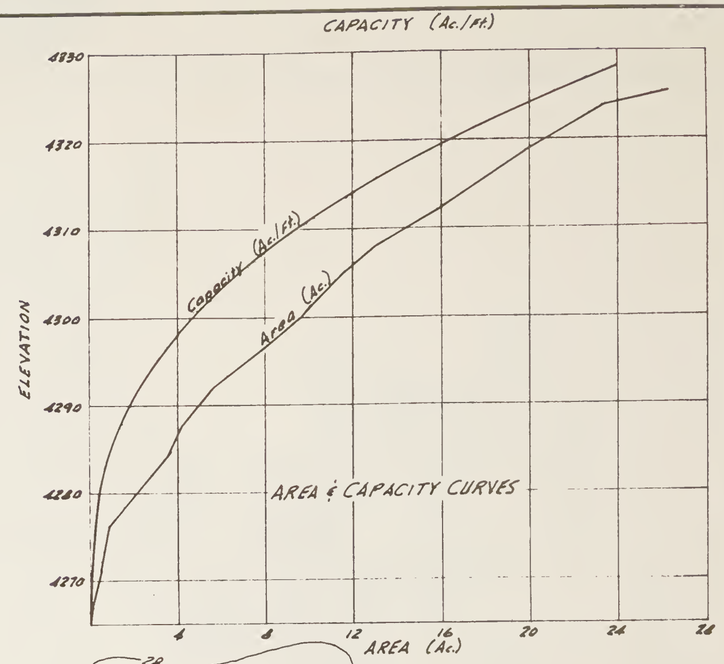
"Wildlife inhabiting the area in order of importance are scaled quail, Gambel's quail, mourning dove, antelope, and mule deer.

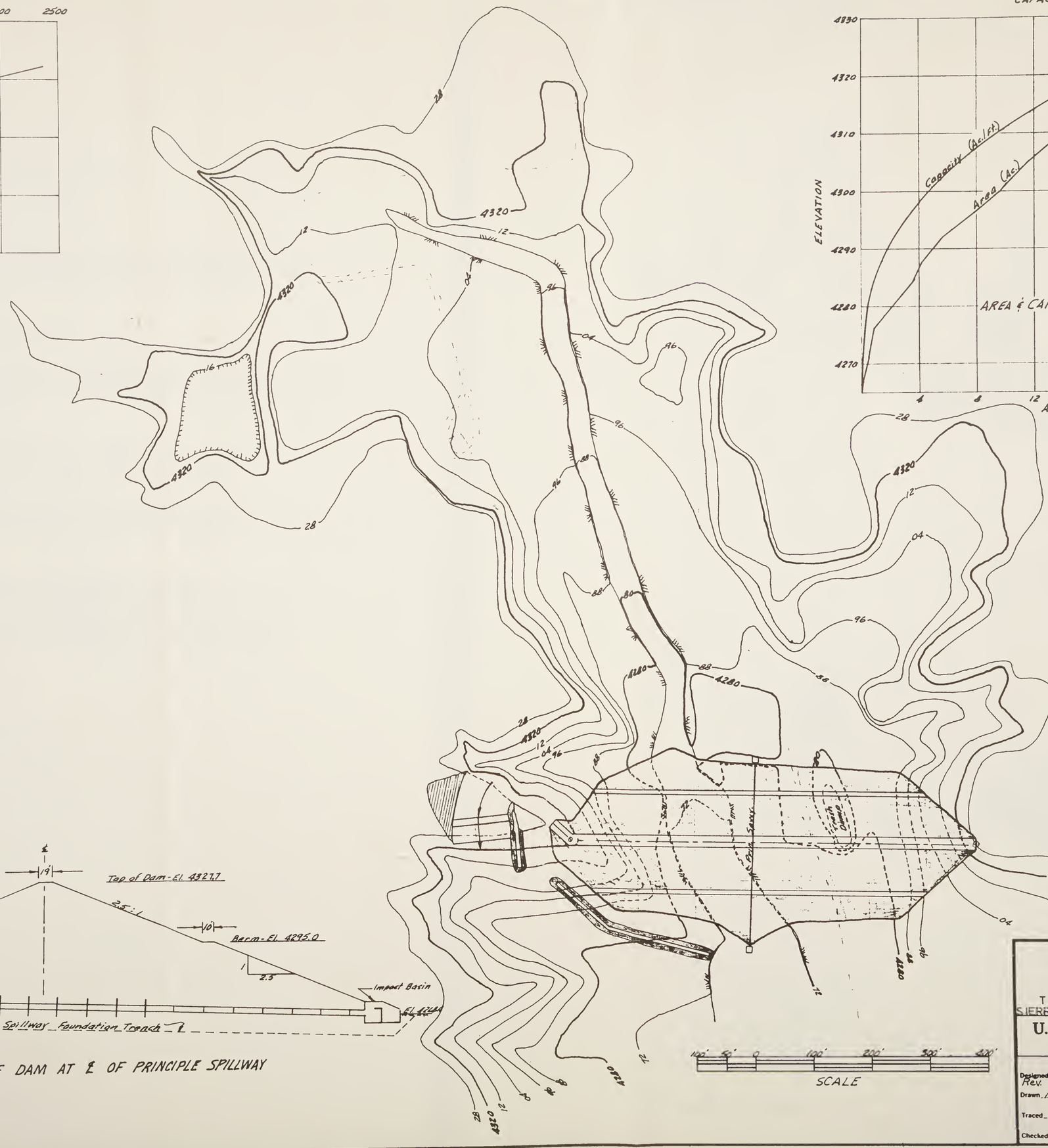
"Recent surveys conducted by the New Mexico Department of Game and Fish show that quail hunters are enjoying modest success in the vicinity of the watershed.

"The planned watershed project would not affect either fish or wildlife habitat adversely. No special mitigation measures are requested. Furthermore, the dry nature of the arroyos and the unavailability of water preclude the development of fishing pools in the floodwater detention reservoirs."



EMERGENCY SPILLWAY DISCHARGE CURVE





CROSS-SECTION OF DAM AT ℄ OF PRINCIPLE SPILLWAY

FIG. 1

PRELIMINARY PLAN

FLOODWATER RETARDING STRUCTURE

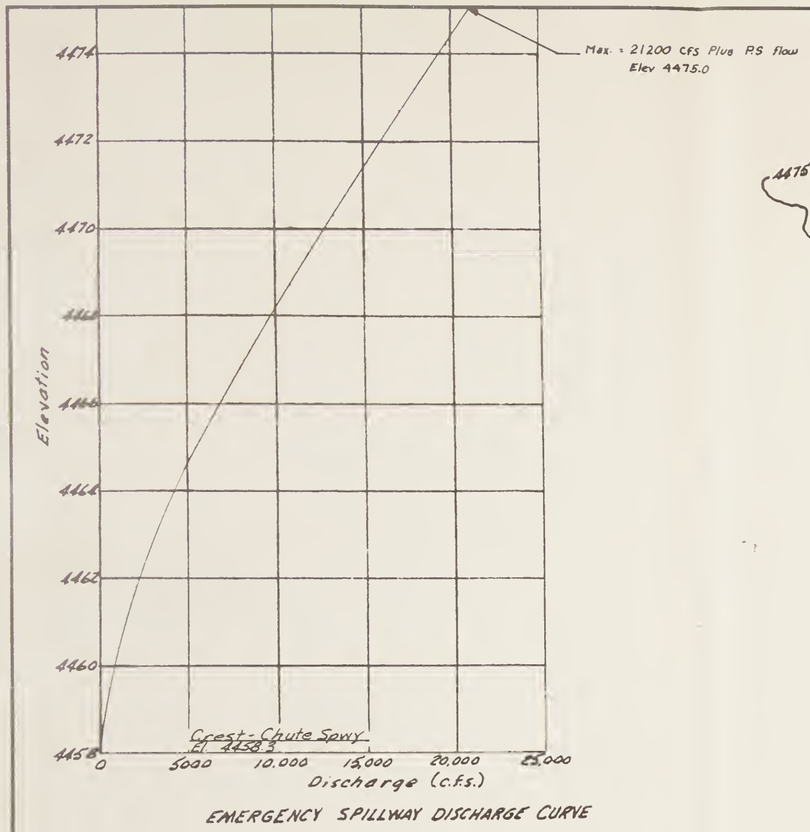
SITE No. 2-A-1

T or C-WILLIAMSBURG ARROYOS WATERSHED

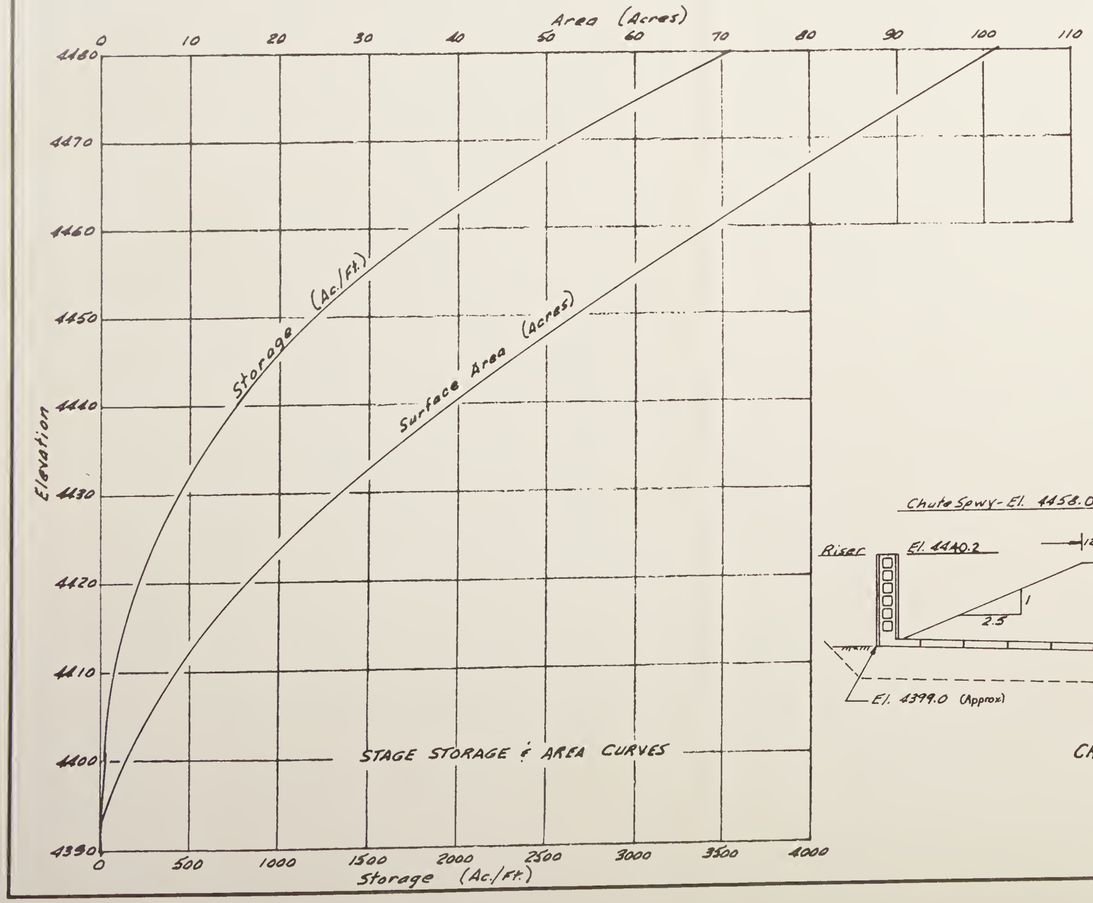
SIERRA CO. NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

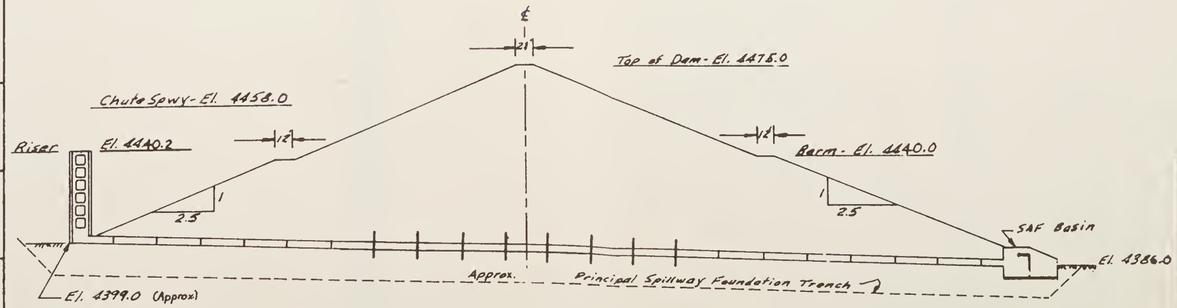
	Date	
Designed L. Mc Dougal	10-69	Approved by
Rev. L. Mc Dougal	3-70	Title
Drawn M. King	10-69	Title
Traced		Sheet No. / Drawing No
Checked		of



EMERGENCY SPILLWAY DISCHARGE CURVE



STAGE STORAGE & AREA CURVES



CROSS-SECTION OF DAM AT ℄ OF PRINCIPLE SPILLWAY

100' 0 200' 400' 600' 800'

SCALE

FIG. 2

PRELIMINARY PLAN

FLOODWATER RETARDING STRUCTURE

SITE No. 8-C

T or C-WILLIAMSBURG ARROYOS WATERSHED

SIERRA CO. NEW MEXICO

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
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Rev. Mc Dougal	3-70	Title	
Drawn M. King	10-69		
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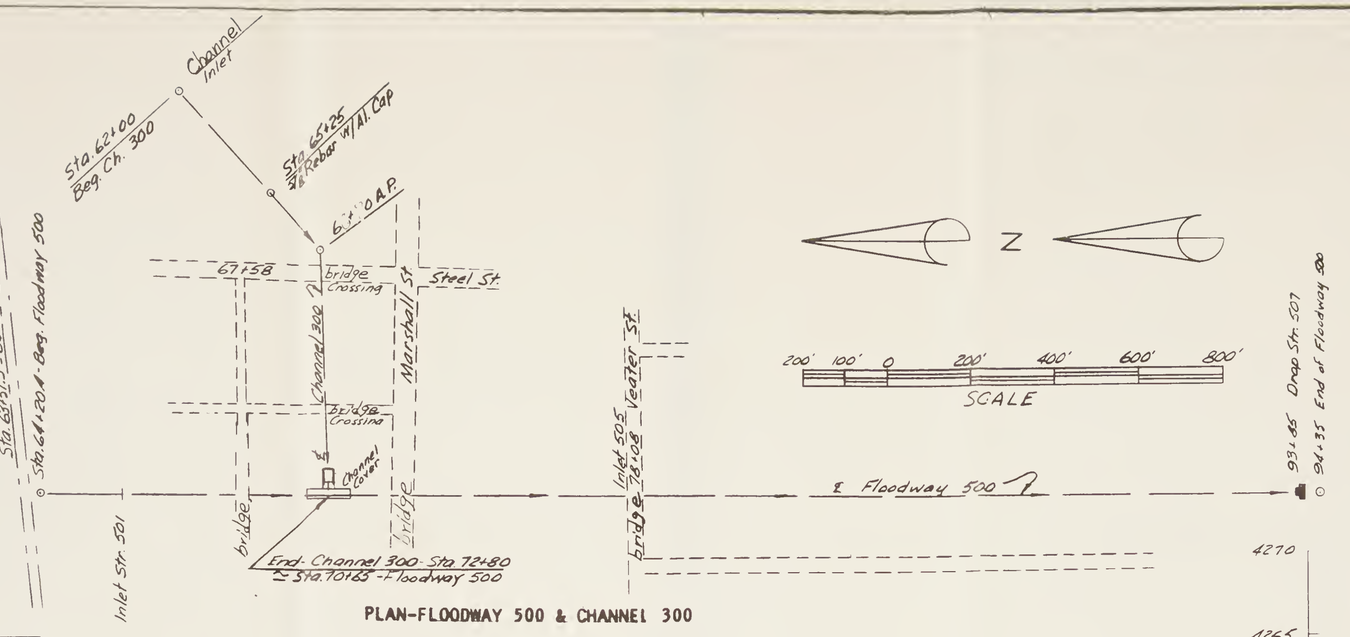
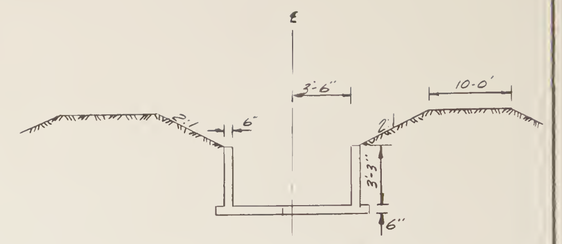
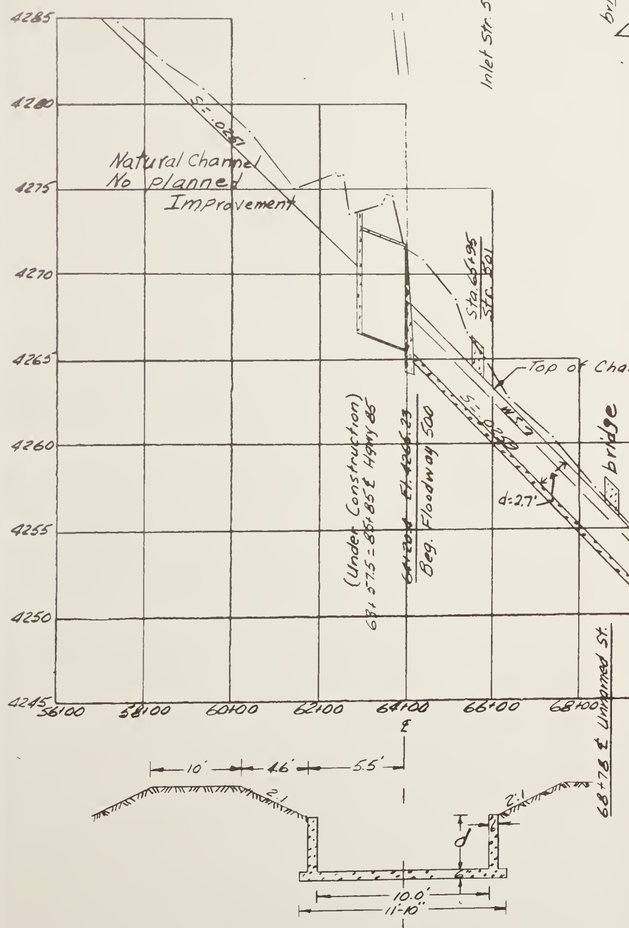


PLAN-FLOODWAY 500 & CHANNEL 300

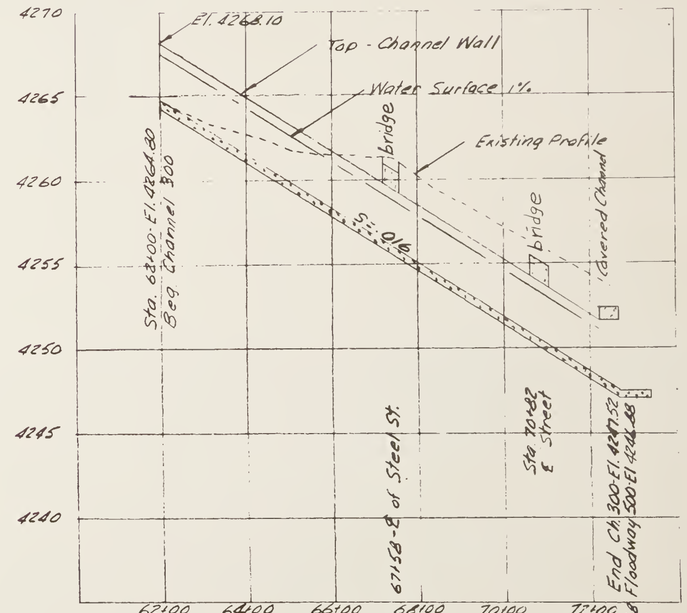


TYPICAL SECTION-CHANNEL 300



TYPICAL SECTION-FLOODWAY 500

PROFILE-FLOODWAY 500



PROFILE-CHANNEL 300

FIG. 3

PRELIMINARY PLAN AND PROFILE
FLOODWAY 500 & CHANNEL 300
T or C-WILLIAMSBURG ARROYOS WATERSHED
Sierra County New Mexico

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed J. Ramsay	3-70	Approved by:
Drawn M. King	3-70	Title:
Traced		Title:
Checked		Sheet No. of / Drawing No.

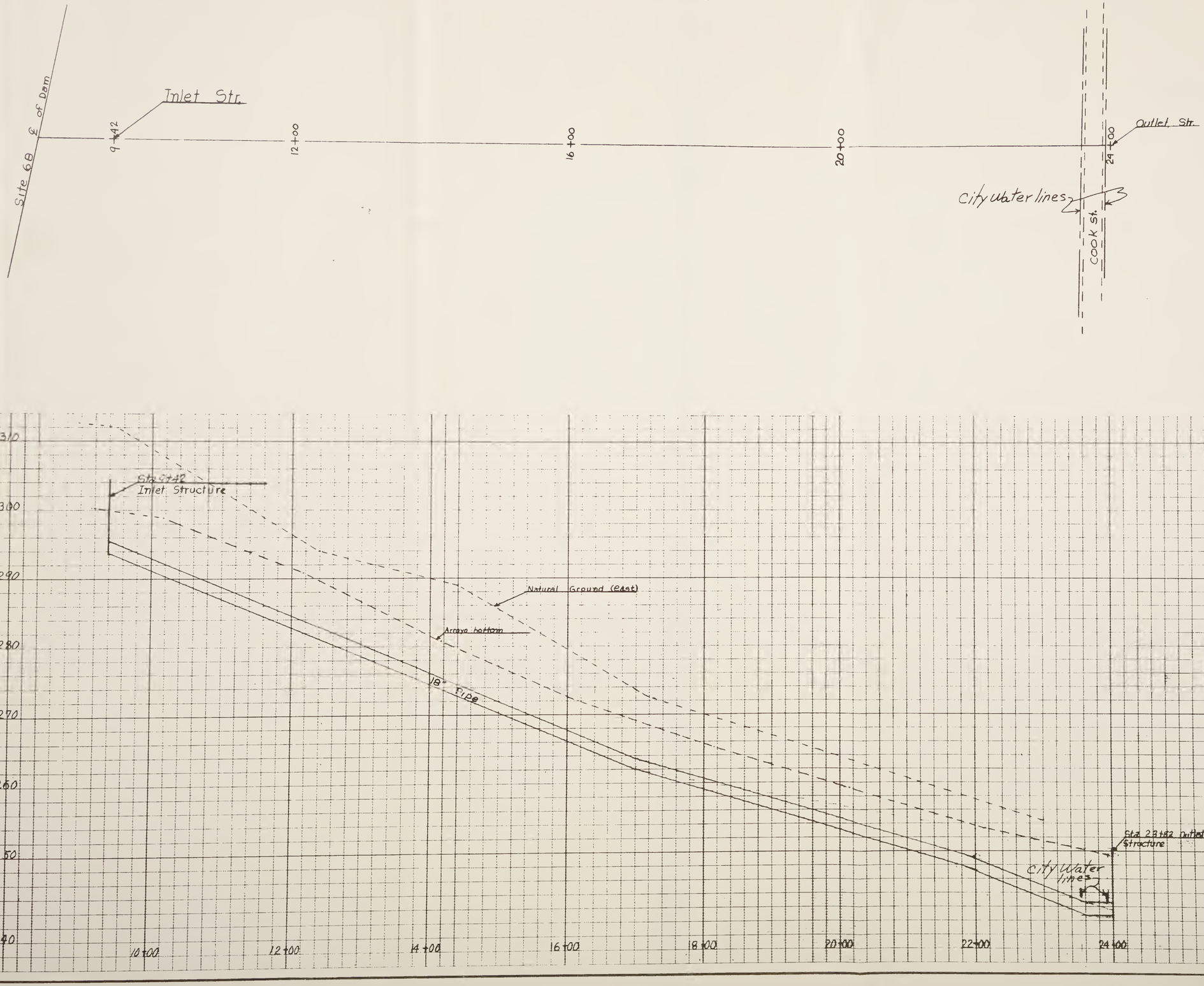


FIG. 4

PRELIMINARY PLAN AND PROFILE
OUTLET 600 (DRAIN PIPE)
TorC-WILLIAMSBURG ARROYOS WATERSHED
Sierra County Area 4 New Mexico

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed Ramsay	3-70	Approved by	
Drawn McDougal	4-70	Title	
Traced		Title	
Checked		Sheet No. of	Drawing No.

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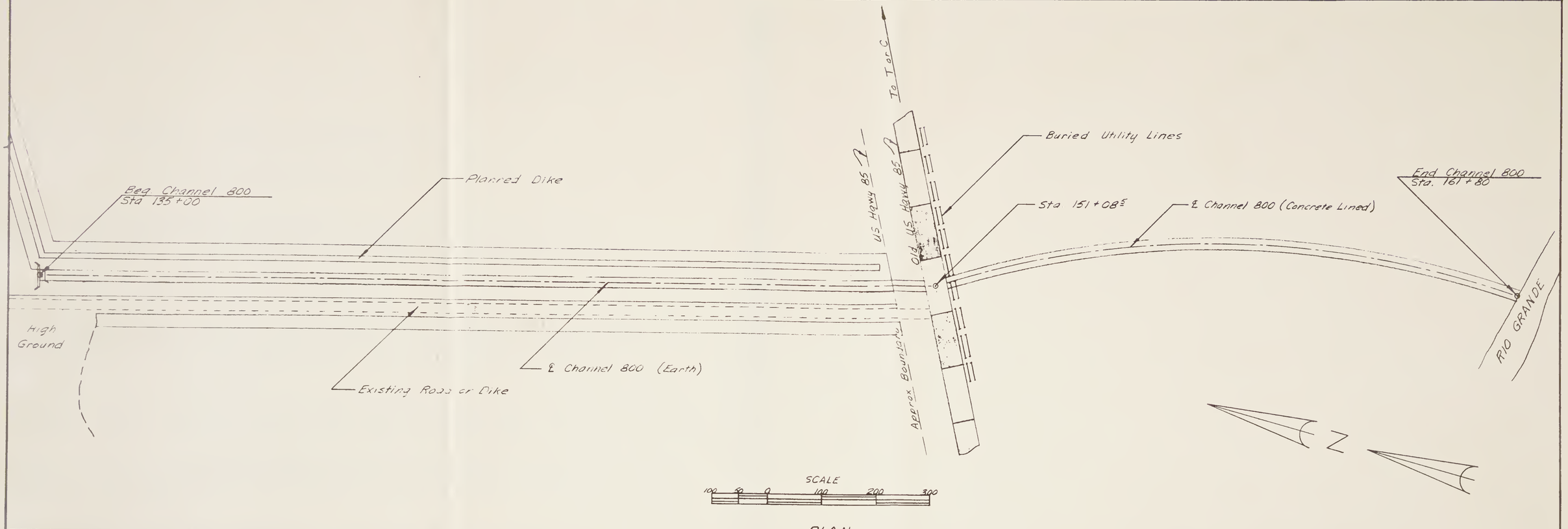

PRELIMINARY PLAN AND PROFILE
CHANNEL 800
T or C-WILLIAMSBURG ARROYOS WATERSHED
Sierra County New Mexico

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Date	Approved by
L. Mc Dougal	3-70	Title
Drawn		
M. King	3-70	Title
Traced		Title
Checked		Sheet No / of; Drawing No.

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TABLE OF SOIL CHARACTERISTICS, RELATED FACTORS AND INTERPRETATIONS
TorC-Williamsburg Watershed, New Mexico

Soil Association and Soils Series	% of Assoc.	Slope Range %	Avg. Slope %	Surface Soil Texture	Control Section Texture	Average Soil Depth (in.)	Dominant Vegetation	Total Water Holding Capacity	Permeability	Hydrologic Group	Drainage	Erosion Hazard	Present Erosion	LUC Irr.	LUC Dry	Range Site
1. Anapra	40	0-1	0.2	sicl	sicl	60	cult.	8-10	slow	C	somewhat poorly	slight	slight	IIs	VIs	bottom land
Gila	45	0-1	0.2	sl	sil	60	cult.	8-10	mod.	C+ B	mod. well	slight	slight	IIe	VIe	bottom land
Clays-Sandbars, Misc.	15															
2. Bluepoint	80	3-15	5	ls	s	16	prickly pear creosote bush, yucca drop seeds	2-3	rapid	B	somewhat excessively	very high	severe	-	VIIe	deep sand
RBL	20	15-60	20	land type		--	creosote bush prickly pear	--	--	C	excessively	very high	gullied	-	VIIe	breaks
3. Upham (like)	25	0-5	2	grsl	grsic	36	tarbush yucca	6-7	slow	C	mod. well	mod.	slight	-	VIIs	clayey
Chambrino	65	0-5	1	cl	cl	48	creosote burrograss	3-4	mod.	C	mod. well	mod.	mod.	-	VIIs	loamy
Cutter	10	0-2	1	cl	sic	48	tarbush mesquite	6-8	slow	C	mod. well	slight	slight	-	VIs	bottom land
4. Upton	20	0-9	2	grl	-	4	desert shrubs	-	slow	D	somewhat excessively	high	severe	-	VIIs	shallow
Other																
RBL	(See Association No. 2)									C						
5. River Wash	50	0	1	land type		--	arrow weed salt cedar	-	rapid	A	well	none	slight	-	VIIIs	
Gravelly Alluvial Land	45	0-8	3	land type		--	prickly pear mesquite blue grama	-	rapid	B	somewhat excessively	high	severe	-	VIIs	gravelly
6. Badland	20	20-100	50	land type		--	--	-	--	C	excessively	very high	gullied	-	VIIIe	
RBL	65	(See Association No. 2)								C						
7. Gravelly Alluvial Land	55	(See Association No. 5)								B						
Vinton	45	0-5	2	sl	sl	60	mesquite annual weeds	7-9	mod.	B	well	high	severe	-	VIe	sandy
8. Rockland	--	15-75	25	land type		8	creosote cholla prickly pear	-	mod.	D	excessively	mod.	slight	-	VIIe	limestone hills
Rock outcrop	45															
grl over Rock	55															
9. Upham (like)	80	(See Association No. 3)								C						
Cutter	15	(See Association No. 3)								C						
Chambrino	5	(See Association No. 3)								C						

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LEGEND

1. Gila - Anapra
2. Bluepoint - Rough broken land
3. Chambrino - Upham Like Cutter Association
4. Rough broken land - Upton
5. Riverwash - Gravelly Alluvial
6. Badlands
7. Gravelly alluvial land - Vinton
8. Rockland
9. Upham - Like Cutter Association.

This map is intended for general planning. Each delineation may contain soils different from those shown on the map. Use detailed soil maps for operational planning, and on site inspection for more detailed decisions.

FIGURE 6

GENERAL SOIL MAP

T OR C - WILLIAMSBURG ARROYOS WATERSHED

SIERRA COUNTY, NEW MEXICO

JANUARY 1971

1 0 MILES

SCALE 1 72,000

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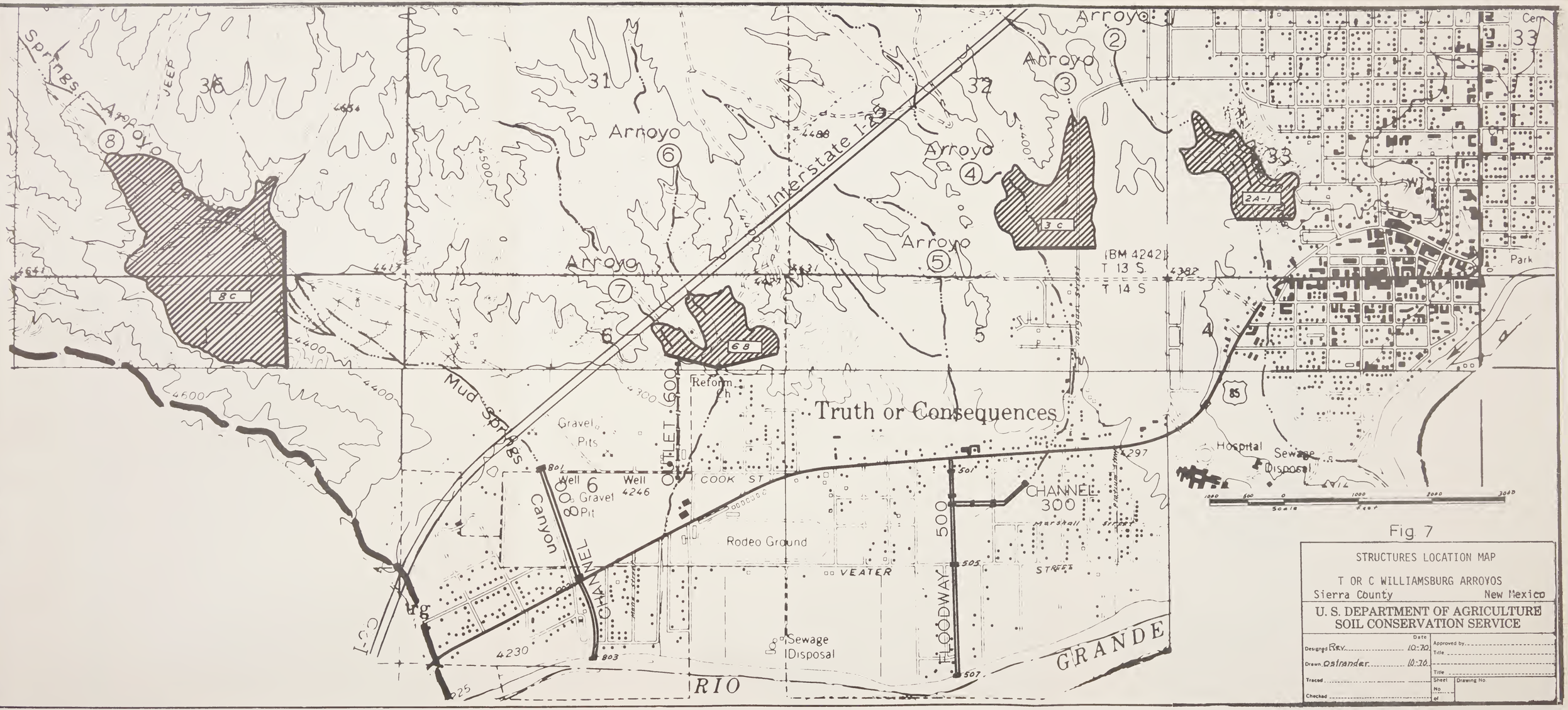


Fig. 7

STRUCTURES LOCATION MAP

T OR C WILLIAMSBURG ARROYOS

Sierra County New Mexico

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed RKV	10-70	Approved by	
Drawn Ostrander	10-76	Title	
Traced		Title	
Checked		Sheet No.	Drawing No.
		of	

Fig. 8

URBAN FLOODPLAIN MAP

T or C–WILLIAMSBURG ARROYOS WATERSHED

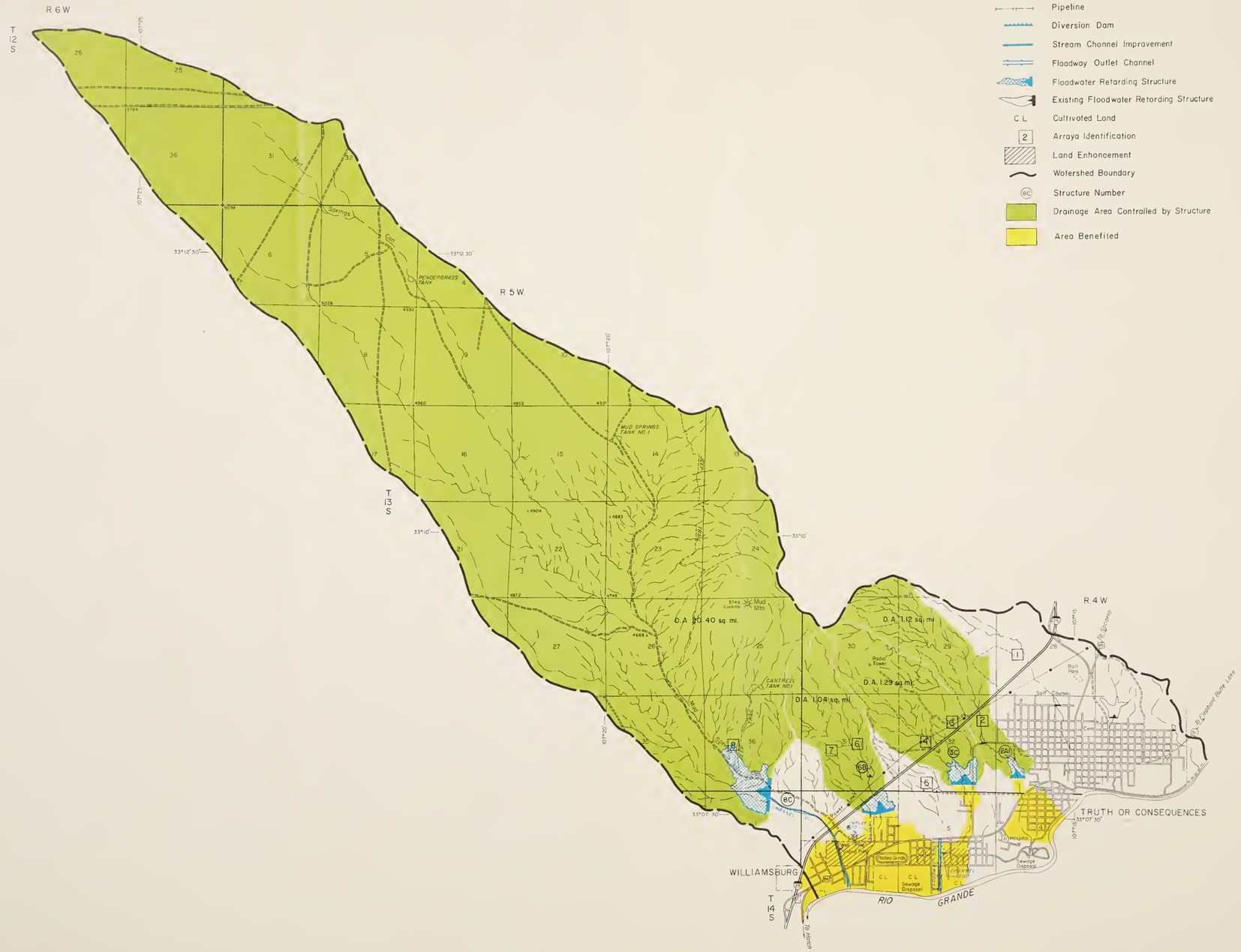
Sierra County Area 4 New Mexico

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed		Approved by	
Drawn L. McDougal	3-70	Title	
Traced		Title	
Checked		Sheet No. of	Drawing No.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



LEGEND

- Pipeline
- Diversion Dam
- Stream Channel Improvement
- Floodway Outlet Channel
- Floodwater Retarding Structure
- Existing Floodwater Retarding Structure
- C.L. Cultivated Land
- 2 Arroyo Identification
- Land Enhancement
- Watershed Boundary
- (6C) Structure Number
- Drainage Area Controlled by Structure
- Area Benefited

FIGURE 9

PROJECT MAP

T OR C - WILLIAMSBURG ARROYOS WATERSHED

SIERRA COUNTY, NEW MEXICO

JANUARY 1971

0 MILES

SCALE 1 72,000

M7-S-2192IA-N